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ABSTRACT

This report describes a 9-month project, conducted in seven states, during which teaching strategies and teacher attitudes which successfully encouraged girls in science were observed, described, and analyzed. Biology, taken by over 80 percent of high school students, was the course selected for observation; if girls are turned off to science in biology, they effectively close the doors to scientific or technological careers. Following a brief introduction, eight case studies of teachers who have had a "track record" of success with young women in science are presented. Authors of these studies are Exyie Ryder, Jane Butler Kahle, Ann Haley-Oliphant, Julia Riggs, Frances Vanderdoort, Jane Abbott, Joseph McInerney, and Elizabeth Stage. A summary is also provided in which data collected at all the case study schools is analyzed, case study sites and teachers compared and contrasted, and general conclusions drawn. Several behaviors of teachers who are successful in encouraging girls to pursue science were found. They include: (1) providing career information and informal academic counseling; (2) demonstrating unisex treatment in science classrooms; and (3) not using sexist humor and not allowing boys to dominate discussions or activities. (JN)

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GIRLS IN SCHOOL : WOMEN IN SCIENCE

Jane Butler Kahle

October, 1983

The material in this report is based upon a project, "Factors Affecting the Retention of Girls in Science Courses and Careers: Case Studies of Selected Secondary Schools," funded by the National Science Foundation (Order Number: 83-SP-0798).

The opinions, findings, and conclusions are those of the authors and do not necessarily reflect the views of the National Association of Biology Teachers or the National Science Foundation.

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GIRLS IN SCHOOL: WOMEN IN SCIENCE

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Preface

Jane Butler Kahle
Professor of Biological Sciences & Education
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In 1981, the National Association of Biology Teachers (NABT) formed a special committee, the Role & Status of Women in Biology Education Committee, whose title describes its purpose. The first member was Marjorie Behringer, a retired professor dedicated to improving the professional status of women. Her presence encouraged others to accept the challenge of serving on the committee and has continued to inspire their work. Jane Butler Kahle agreed to be chairperson, and Joseph McInerney, Frances Vandervoort, Mildred Collins, and Claudia Douglass were apppointed. Later Ann Haley-Oliphant and Marsha Lakes Matyas joined the committee.

The committee's activities have focused on assessing, describing, and improving the role and status of women biology educators. First, they conducted the first national comprehensive survey of NABT's members in order to compare and contrast its women and men members. Two publications concerning their findings, "A Profile of NABT: The Results of the 1982 National Survey of the National Association of Biology Teachers" and "Professional Equality as Reported by Biology Educators," are in press. Next, they undertook a historical, international, and educational review of women in science, especially in biology. This work has been accepted for publication under the title of Women in Science: A Report from the Field (Falmer Press). Last, they conducted in-depth case studies of high school teachers who had been successful in encouraging girls to continue in science. This work was partially funded by the National Science Foundation (Order Number: 83-SP-0798) and is reported in this document. Concurrent with these activities the committee has maintained a high profile by sponsoring symposia and papers describing the contributions of women and minorities, delineating research concerning women and minorities, and presenting special resources for women and minorities at NABT's annual convention. These varied activities have enabled the committee to accurately describe the role and status of women in biology and to prescribe options to improve both.

This report describes a 9-month project, conducted in seven states. Committee members, supplemented by other concerned researchers, sought to observe, describe, and analyze teaching strategies and teacher attitudes which successfully encouraged girls in science. Biology, taken by over 80% of high school students, was the course selected for observation; for if girls are turned off to science in biology, they effectively close the doors to scientific or technological careers. After a brief Introduction, the individual Case Studies are presented. These are followed by a Summary in which data collected at all the case study schools is analyzed, case study sites and teachers are compared and contrasted, and general conclusions are drawn. Last, the Appendices include the organizational materials as well as the surveys used in all case studies. It is anticipated that readers will gain insights, interpret vignettes, and draw conclusions based on the reported observations and data that will improve biology and science education for all secondary students — but especially for girls.

Introduction

Jane Butler Kahle

Two types of people have contributed greatly to the information included in this report: Case Study Researchers, the people who conducted the studies and described their observations and Case Study Teachers, the classroom instructors who were observed and who assisted by distributing and collecting surveys, by being interviewed, and by arranging for the researcher to interact with administrators, parents, and students. It is important to know how members in each group were selected. Initially, all members of the Role & Status of Women in Biology Education Committee were asked to conduct a case study; some declined because of other commitments. Additional researchers, then, were sought to provide geographic, racial, and socio-economic representation in the various case studies. Researchers also were selected on the basis of their known abilities to conduct research and to write lucidly. All were experienced researchers. The distribution of the case study researchers resulted in the following types of case study sites.

Case Study	Researcher	Community & School Description
A	Exyie Ryder	Small city, South, Black
B	Jane Butler Kahle	Small rural town, Midwest, White
C	Ann Haley-Oliphant	Suburban, Midwest, White
D	Julia Riggs	Small city, South, Hispanic
E	Frances Vandervoort	Urban, Midwest, Black
F	Jane Abbott	Small town, Northeast, White
G	Joseph McInerney	Small city, Rocky Mountain, White
H	Elizabeth Stage	Urban, West Coast, Mixed

Each researcher was free to select a case study teacher for his/her report. The basic criterion was that the one selected had to have a "track record" of success with young women in science. The following guidelines were provided, but each researcher was completely free to make his/her final choice.

> The selection of a teacher who has a proven record of success in encouraging girls to stay in science is critical to the success of each case study. Informal discussions with students, parents, and administrators may help you narrow down your choice. A visit to the guidance office to examine enrollment records may provide useful information. For example, the number of girls enrolling in physics or chemistry who can be traced to a particular biology teacher can verify success rate. The last criterion, which must be met, is the identification of 4-6 women who have continued into college science majors, science or professional graduate schools, or science careers. Names and addresses for these students must be procured in order to complete the past student survey.
>
> Next, the teacher must be willing to be observed, to complete several surveys (requiring about two hours), and to allow the collection of data on his/her students. Student assessments will require approximately three hours and should be given to all classes at the same level (i.e., advanced biology, beginning biology). However, the teacher can distribute them at his/her convenience (prior to April 30), and does not have to grade them. In addition, you will probably need at least one after-school interview with the teacher and several short ones with individual students. The teacher selected must be agreeable to all of these interruptions.
>
> In the process of selecting a teacher, be certain to warn him/her of all these interruptions and demands. In addition, the teacher should be able to provide you with the following items:
>
> a course of study (for observed class)
> class lists
> tests
> teacher and student handbook for school.
>
> These items will simplify your writing and should be appended to your initial report. Although the identity of the school will be removed in any published version, these items can be part of our report to the National Science Foundation.
>
> Each case study worker will have a different situation and all of these procedures (and some of the measurements suggested) may have to be modified. Our hope is to have as complete a record as possible in order to provide consistency among the studies. Obviously, opportunities to compare and contrast among the schools will be increased if each furnishes complete data.
>
> The teacher should be informed that the purpose of the case study is to explore the reasons for their track record in encouraging students to enter science careers. Until the case study is well underway do not emphasize any special concerns about girls in science. This strategy is necessary to prevent sensitization of the teacher and the introduction of any changes in their usual behavioral and teaching patterns.

Although it was hoped that certain standardized data could be collected, the primary aim of the study was the thoughtful observation and analysis of teacher behavior and student/teacher interactions. The intent of the overall project was to identify instructional strategies or teaching behaviors among the teachers, from the rural South to urban Midwest, which could be adopted by other teachers to improve the retention and achievement of girls in science classes and the entrance and success of women in science careers.

Each of the following case studies is unique; each describes a successful teacher, working in an exciting learning environment or a drab, oppressive one. Each reports a teacher's actions and some students' dreams. Commonalities may be found, but what is most obvious is that a concerned teacher makes a difference. A science teacher who says, "Yes, you can!" is heard and does influence the lives of many of her/his students.

The individual researchers followed a suggested outline in preparing their report, and editorially each case study was organized into a standard format. However, in some cases, information was missing and, therefore, a section was omitted. For example, some researchers focused on the schools, others on the teachers, and still others on classroom observations. Each study is individual, reflecting the priorities and insights of the involved teacher, students, and researcher.

The concluding chapter searches for commonalities and identifies positive actions. It is neither exhaustive nor complete. It is hoped that each reader will bring a fresh perspective to the material and suggest new solutions to the problem. Until capable girls are retained in science and mathematics classes and until their achievement levels match their abilities, success will be elusive for women in science.

Case Study A

Exyie Ryder
Associate Professor of Education
Southern University

I. THE COMMUNITY

The area of study is a medium-sized city located in a south, central state. With a population of nearly 500,000, the greater metropolitan area consists largely of single-family homes, although over the past decade, there has been a sharp rise in the number of apartment complexes and other multi-unit dwellings.

The city is the home of two major state-supported universities: a large, predominantly black university; and the state's largest comprehensive university. The universities, along with the petrochemical industry, which dominates the employment scene, provide employment for a majority of the work force. Job levels include blue collar, semi-skilled, technical, and highly professional.

There are 130 public schools in the metropolitan area - ten of which are senior high schools. The racial composition is approximately 45:55 black/ white. Since the predominant religion in this part of the state is Catholic, approximately 20 percent of the students in the city attend Catholic schools. There are many other types of private schools that attract students, and there is also the choice of allowing a child to remain at home and be taught by her/his parents. In addition to these schools, each of the two universities operates a laboratory school. Laboratory schools are identified as semi-private or semi-public since they adhere to a selective admissions policy, and also because students are assessed a tuition fee. Since the laboratory schools are in close proximity to the universities with which they are associated, they are held in high academic esteem and are frequently compared to the city's magnet schools.

II. THE SCHOOL

One of the university laboratory schools was the setting for this case study. Located on campus, the laboratory school is a department within the College of Education. It has as its chief administrators a principal and assistant principal, a male and female, respectively. The principal is directly responsible to the Dean of the College of Education. Decisions pertaining to Laboratory School policy are generally made by the Executive Council of the College of Education, a governing body of which the principal and the Dean of the College of Education are members.

Other academic personnel at the school include a male guidance counselor, a female librarian, and 33 faculty members, about 75 percent of whom are females. At the junior and senior high school level, there are two male and two female science teachers. Of the two science teachers for grades 9-12, the biology/physical science teacher is female, and the physics/chemistry/physical science teacher is male.

The school is accredited by the Southern Association of Schools and Colleges and by the State Department of Education. Described as a college preparatory school, its curriculum is designed for the college-bound student. Classes are expected to be challenging, rigorous, and competitive, and the grading standards are maintained at a relatively high level. Because of its affiliation with the university, the laboratory school is accessible to college students and faculty who wish to observe, collect data, conduct educational or psychological experiments, or test and demonstrate ideas. Nursery through high school has a total enrollment of slightly more than 600 students. In the elementary division (grades nursery through 6), there are 200 students (one class per grade), and in grades 7 through 12, there are in excess of 400 students. These students are drawn from the metropolitan area and, for the most part, from middle-class, professional, two- income families. Their religious affiliation is mainly Protestant. The racial composition of the faculty and student body is 100 percent black.

Transportation of students to and from the laboratory school is provided by parents, usually in the family car. Parents work closely with the school in the support of curricular and extra-curricular activities, and are quite visible in the school as volunteers. The interest and close involvement of parents are reflected in the students' behavior. Compared to other schools in the city, the laboratory school experiences very little vandalism, little truancy, and few discipline problems.

The laboratory school follows the university calendar. It opens the third week in August and closes the second week in May of each year. Classes are 60 minutes long and meet five days per week. The average class size is 20, and in most classes, the teacher also serves as supervisor of one student teacher. Team teaching is not regularly engaged in, however, teachers do utilize many audio visual aids and a variety of instructional methods.

Grading is on a 4, 3, 2, 1, 0 point scale with equivalent letter grades of A, B, C, D, and F, respectively. Standardized achievement tests are administered periodically to assess student progress as well as to aid in curriculum evaluation. All juniors and seniors take the PSAT, SAT, and ACT. The average ACT score attained is 19, while the average ACT score for students who have pursued careers in science is 24. Records indicate that 85 to 90 percent of the laboratory school graduates finish college.

Students and teachers are enthusiastically engaged in extra-curricular activities such as the band, choir, science club, mathematics club, athletic teams, and the Key Club. During special times of the year, some student organizations sponsor community projects. Many students are involved in numerous school clubs and organizations.

Students show great pride in their school and are extremely proud of the fact that they are identified with the university. Being a part of the university enables the seniors to take college courses for college credit. In addition, all laboratory school students are given preferential admission to special academic programs and to other university events.

Extensive interviews with the principal and guidance director revealed some interesting aspects of the science instruction. For example, in response to a question concerning any special attention paid to scheduling science classes, the principal answered.

> This year we have [changed] our curriculum...to require 3 years of science. We think it is important, especially [since we are] a college prep [and] 95% of our kids go on to college. We have been able to follow up on them. We stress the importance of science and it was very good to get back into our building so we could work in our labs [again]. Exxon has just donated a very fine piece of equipment to us to help us in terms of our science instruction, so we are working at it and are trying to do more, and we are getting ready to reimplement our science fair starting next year.

He added the following later in the interview.

> We have been working at making our curriculum more relevant and [have been] requiring a bit more of the basics as the requirements indicated by the national surveys in terms of a college prep school. I think our kids have been responding well. We tend not to have some of the problems a lot of public schools [face] but we do stress academics and we do encourage our students to be involved, and our students are involved in quite a few things.

The principal also stated that the school had an excellent girls' athletic program. He did not compare it with the boys' program or note any other differences between the girls' and boys' curricular and extra-curricular educational experiences.

The interview with the guidance director focused on career information as well as any special advising in math and science. The following partial transcript of this interview shows that the counselor is cognizant that special encouragement may be needed to attract and keep young women in science.

Question: As a counselor, I know you provide students with career information. Do you have any special ways of advising students into careers?

> We are in the process of putting more emphasis on career counseling. Our funds come through the university and I have brought quite a bit of information to them to improve our program on careers. The kids come in and say that they don't know what to go into and I say, 'Well, you are doing well in math or you are doing well in science, so go into math or science.' We need more people. In the future there is going to be a shortage of teachers

in science and math. I feel the federal government may appropriate some funds in higher education in science and math to attract more young minds into these areas.

Question: As a former math teacher, did you find there was a difference in the performance or interest of girls and boys in your math class?

In the past I didn't find very much difference in the performance. I found that girls did as well as the boys.

Question: Do you counsel students at the junior high level also?

I call myself the Director of Counseling since I am the only counselor here and counsel from nursery through the 12th grade.

Question: At the junior high level, if you notice that a student is inclined to be good in the math and science area, do you point this out to him/her and encourage him/her to take courses in these areas?

Yes. It is required for students to take math courses. If he is good I then encourage him to take the advanced courses in math and also attend the various workshops around and math festivals that are held each year.

Question: In the class scheduling, do you have any special way of assigning students to various classes?

At the lab school we have a college-bound curriculum. Therefore, we schedule students to take courses in math and science so that when they get to college they won't be [starting] in remedial courses.

Question: But if you have more than one class per grade, how do you decide how many girls and how many boys will go into a certain class?

We look at the level of points on the achievement tests the students take and we try to put the student in a section where he can actually perform to the best of his ability. This is how we do it, based on test scores.

Question: Do you have any idea of the percentage of girls who volunteer to take science courses that may not be required?

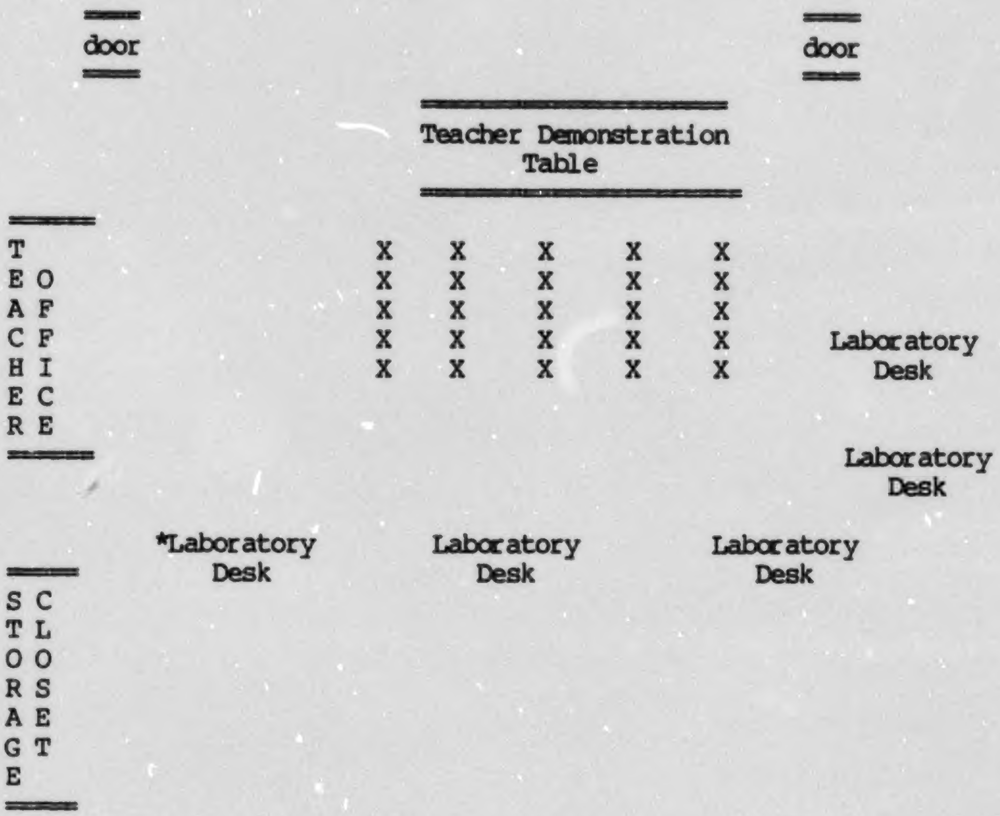
About 25% of the girls would take physics and about 75% of the boys.

Question: Is there any information you might want to offer about the school that you think would be helpful to this project.

I think it is a worthy project and am glad the federal government is interested enough to do it this way. Maybe they will go back to the basics to improve the area of science, to attract more females in science, or to attract more students in science. If we don't attract teachers, we are not going to attract students. I think any help teachers can get will be passed on to the younger generation.

III. THE SCIENCE CLASSROOM

Observations were done during the latter part of April in a 10th grade first year biology class. The room was a combination lecture/laboratory room with movable armchair desks surrounded on two sides by stationary laboratory tables. A teacher demonstration desk was centered near the chalkboard at the front of the classroom.


door
door
Teacher Demonstration Table
TEACHER OFFICE
X X X X X
X X X X X
X X X X X
X X X X X
X X X X X
Laboratory Desk
Laboratory Desk
*Laboratory Desk
Laboratory Desk
Laboratory Desk
STORAGE
CLOSET

* A laboratory desk seats 5 students.

Each laboratory desk was equipped with gas, water and ample storage space. The spacious room received sufficient natural lighting from the windows in addition to the light provided by flourescent lighting. The room was comfortably air conditioned. On the bulletin boards were charts and diagrams, and around the room were various science teaching aids and instructional materials. The room also contained an aquarium and terrarium. Microscopes were housed in a locked cabinet in the storage room.

The general classroom atmosphere was conducive to teaching and learning. Mannequins, skeletons, and other teaching aids were attractive, easy to handle, and explicit. The room was conveniently equipped with a screen for use with slides, films and filmstrips, and overhead projectors.

The case study teacher mentioned that the classroom will be equipped with one or two micro-computers during the next school year and that most of the faculty have already taken courses in computer literacy, computer awareness and/or computer instruction.

IV. THE SCIENCE TEACHER

The teacher who was the focus of the case study is a very personable, articulate, and relaxed individual. In observing her teaching, it was not easy to single out any special attributes which encourage girls to go into science. It was obvious that she ensures their participation by involving them in discussion, assigning specific chores, and calling on them for recitation. The teacher, who is female, probably serves as a scientist role model for the female students in her class. She is a very thorough and exciting teacher who seems to expect the girls to do well in science. This message of expectation is probably never stated directly, but her enthusiasm, interest, and intellect must be stimulating to any girl student who is considering a career in science.

The case study teacher, an Assistant Professor of Education, has taught science for 24 years. Her interest in science during her high school years and the availability of jobs for women in science teaching were important factors in her decision to choose teaching secondary science as a career. As an undergraduate in a private college, she majored in pre-medicine. Then, while pursuing graduate work in biology, she decided to obtain teacher certification also.

She has received positive feedback about her teaching from parents, school administrators, and former students. She states two general goals for her biology students:

> [First,] to acquire a knowledge of science to the degree that it is useful to the student in preparation for college and in preparation for being a good citizen in the community; [and, second,] to achieve the skills and knowledges that are needed to perform [well] in the future in areas that require a science background.

The case study teacher has used a variety of teaching methods and activities in order to accomplish these goals. She has continuously sponsored the science clubs as well as encouraged students to participate in science fairs and in the annual science-mathematics conference. Furthermore, current biology-related issues such as hazardous chemical dumps, genetic engineering, scientific creationism, and medical breakthroughs have all been discussed in class. As stated by the case study teacher,

> I feel the need to expose the student to various avenues of thinking about an issue and [help] them to learn how to make good, sound decisions.

Through the years, she has kept abreast in science teaching and in biology by returning to study periodically and by remaining active in local, state, and national professional organizations. She feels that attending conferences allows her to "make contact" with new materials. Furthermore, she finds the professional journals especially useful:

> [T]hey keep the science teacher up-to-date on current research, current practices, [and] current materials. They elevate the mind by activating the thinking to a point where science teachers can stimulate students.

Finally, in reflecting upon her teaching career, the case study teacher emphasizes the impact that a single teacher can make:

> In the years I have been teaching, I have become, what I call, dedicated. I try to be professional, and I have influenced the lives of many young people. I have taught required courses and had the opportunity to touch every student who has been through the laboratory school for the last 24 years. I enjoy teaching.

V. THE CASE STUDY STUDENTS

During 10-20 minute interviews, several students who were enrolled in the case study teacher's biology course discussed their opinions about the course and their future plans. Most students indicated that the laboratory work, especially using the microscope, was their favorite part of the classwork. Several mentioned field trips as their favorite activity while others enjoyed learning about the human body. One student stated:

> I enjoyed working with microscopes. [Once] we had a cow heart and we opened it up. [We] looked in the microscope at the different parts of the inside of the heart and I enjoyed that. I enjoy field trips and having guest speakers in class. Sometimes the class above us will come back to this class and tell us what will happen next year and what we have to look forward to.

All of the students interviewed felt free to ask questions in class and often did so. When asked about class discussion of current events, the students mentioned several topics including heart and liver transplants, chemical dumps, and nuclear waste. One student commented on discussions about chemical dumps:

> We talk about the chemical waste sites and everyone gets a chance to tell how they feel about it. They are just making these chemical dumps where they please and [do not think about] how they will affect them in the future.

Most of the students thought that their science and math studies were useful now and also would be useful in the future. Perhaps reflecting this perception, nearly all students interviewed planned to take both chemistry and physics during their last two years of high school.

Although some of the students interviewed did not have definite career plans, the great majority expressed interest in careers in medicine or engineering. Many of these students received encouragement from their teacher(s) and, quite often, from a parent or other relative. These role models and/or supporters seemed to have considerable impact on the students' career plans. Finally, students discussed their perceptions of scientists. Most viewed scientists quite positively. They described scientists performing experiments with chemicals and living organisms, helping people, solving problems, and being dedicated to their work. One student indicated that a scientist had certain characteristics:

> A scientist is a person who is working with the present and the future, trying to make things better for the world. A scientist has to have a personality that is not snappy. They have to have an open mind, have to be thinkers, and be able to understand. [They should] never really take sides. If one person says something they should have to look at that person's investigation [to] see, not just jump to conclusions.

Students had some difficulty deciding whether men and women could be good scientists, good spouses, and good parents simultaneously. The following partial transcript of an interview suggests that students feel scientists may not have enough time to devote to both their family and their career.

Question: Do you think a woman could have enough time to be a good scientist and a good wife?

Yes

Question: Could she be a good wife, good scientist, and a good mother?

No

Question: Do you think a man would have enough time to be a good scientist, and a good husband, and a good father? Why not?

No. It depends on who the person is, but I don't feel that he could because he wouldn't have enough time [along] with his work to spend time with his children and his wife.

Question: Do you think a lady scientist would have that amount of time?

No

Question: Where do you think most of her time would be spent?

In her work.

In general those interviewed felt both men and women could be scientists and would have to work equally hard to do so. Most students realized that more scientists are male but that increasing numbers of women are entering science; the students felt this was a trend beneficial to science. Few students conveyed any perceptions that becoming a scientist or engineer and succeeding in those careers could be more difficult for a woman. When asked why she thought there are more men than women scientists, one female student responded:

> I think when [women] first started out in science courses, they didn't think [they] would be able to handle the jobs. I guess more women believe[d] this too and just went on believing it and didn't try to go into the field.

VI. TEACHER/STUDENT INTERACTIONS: CLASSROOM OBSERVATIONS

Observation Session 1

The lesson for the day includes an introduction of the Unit on Reproduction. Plant Reproduction is discussed first. For most of the class time, the case study teacher lectured, drawing illustrations on the chalkboard and calling attention to diagrams in the textbook. She stressed the necessity for reproduction and intermittently asked students questions. Many students volunteered to respond to these questions, and the students showed considerable interest in the lesson. It was apparent, however, that more female students than male students had read the assignment before coming to class.

Only two interruptions were observed during the lesson: male students were reminded to pay attention, and a female student asked to put her head on her desk due to a headache. At the end of the class period, the teacher handed out a sheet of study questions. Most students began to work on them immediately.

Observation Session 2

Eleven days after the first observation session, the class was again observed. The teacher reviewewd a set of study questions with the students. The students responded enthusiastically with more female than male students volunteering to answer. The teacher called on students by name; nine males and eight females responded.

Table 1. Classroom Observation Data.

Observation Session	1	2	3	Average
No. of Males	11/52.4%	10/50%	11/52%	10.7/51.6%
No. of Females	10/47.6%	10/50%	10/47.6%	10/48.4%
No. of Responses in Class by Sex				
Males	4/30.8%	9/52.9%	5/55.6%	6/46.1%
Females	9/69.2%	8/47.1%	4/44.4%	7/53.8%
Race of Students	B	B	B	
Sex of Teacher	F	F	F	
Race of Teacher	B	B	B	

It is notable that approximately 50% of the students asked questions. When the number of responses is broken down by gender, girls and boys responded about equally (22/18). However, girls responded twice as often as boys during the first observation, which supports the observer's comment that more girls had read the lesson. There was no sex-stereotyping in number of student responses in this classroom.

Observation Session 3

A week after session 2, the class was observed for the last time. The case study teacher presented slides on the human reproductive system. Three female and two male students volunteered to read from the slides. Although students found certain information amusing, the case study teacher "calmed them down." When students mispronounced words, the case study teacher corrected them; and when students asked sincere questions, the teacher gave thorough answers.

VII. TEXTBOOK ASSESSMENT

The textbook used for the biology course was Biological Sciences Curriculum Study, *Biological Science: An Ecological Approach*, Rand McNally & Company, New York, 1978. The book was selected by the case study teacher, and it is the textbook used for all three biology classes. At the laboratory school, all textbooks and curricular materials for any course are chosen by the teacher who teaches the course. Textbooks, however, must be chosen from among those appearing on the state approved adoption list.

It appears that the curricular materials are carefully chosen, with particular sensitivity toward acquiring materials that will capture and sustain the interest of students, while at the same time, present the content in an accurate, effective, and challenging manner.

Case Study B

Jane Butler Kahle
Professor of Biological Sciences & Education
Purdue University

I. THE COMMUNITY

The city selected is a sleepy, little river town, the county seat for the occupants of the rich and thriving, Midwestern farming community. At one time, it was a bustling commercial area - first, as a port on the Eric Canal and, later, as a railroad center and site of a major railroad yard. However, with the demise of both forms of transportation, the growth of the city faltered and essentially stopped. The population today (@20,000) is the same as it was 60 years ago, and a recently opened time capsule revealed that the school population is almost identical to the one described in 1923. A town of small manufacturers, surrounded by wealthy farmers, the city serves as the financial, legal, and medical center for the adjacent four counties.

There is a single, city-wide school corporation, with an elected school board. The surrounding county has three school districts, so there are few truly rural pupils in the city system. The system has one high school (grades 9-12), two middle schools (6-8), and five elementary schools (K-5). The total school-age population has declined fairly rapidly over the past five years, leading to reduction and reassignment of teaching personnel as well as several school closings.

II. THE SCHOOL

The city's high school occupies a beautiful, modern complex. The science facilities are outstanding and, due to declining enrollments, under-utilized. The school has a micro-computer laboratory, a spacious science teacher area. well-equipped stock rooms, and specialized laboratories for earth science, biology, chemistry, physics, and electronics. In addition, due to the insight and dedication of the case study teacher, it has a 61-acre natural area, developed and maintained by his biology students. This natural resource has guided paths, labeled specimens, and other natural phenomena; it is frequently used by elementary teachers and students.

Until 1983 the school required only one science course for graduation, although academic students were counseled to take two or three science courses. The recent emphasis on science and mathematics education led the school board to increase graduation requirements to two science courses. However, the case study teacher related that science teachers had little, or no input into the nature of that requirement or how students would meet it. During an interview, he stated:

> Of course, I firmly believe the freshman year is not the level for biology. It is not. And I have gone to the school board, to the administration, and to the guidance counselor. All of them agree with me; but it is just too difficult to change. Freshmen have always had a science. With this increase in science requirements we [the science teachers] are going to try to have some input. But they [the administration] have not asked us about anything. And they won't either. They will decide what they want and what's easiest to plug in. What is going to happen is that we are going to have two years of science. It will amount to covering in two years what we could have covered better in one year 10-15 years ago.

A range of science courses is found in the school's curricular guide. They include: basic earth science, introductory physical science, introductory biology, advanced physics (mechanics, vector analysis, quantum theory, and electronics), electronics, introductory chemistry, advanced chemistry, and aerospace fundamentals. Earth science, physical science, and introductory biology are perceived as basic courses, and they do not have science or mathematics prerequisites. The other courses all have prerequisites — successful completion of a specified science and/or math course often with a specific grade. The science teachers are fearful that public pressure will mandate that the additional science requirement can be met through two basic courses; for example, basic earth science and introductory biology. This concern was voiced by the case study teacher in the following way.

> This is what we are trying to find out. We have teachers with the same attitude, too. Instead of seeing that a kid needs biology, physics, and chemistry, they are thinking, will life science, instead of biology, satisfy the State? And earth science instead of a physics or a chemistry course? Unless there are some controls on these changes, they will be worthless. Real reform means that teachers are going to have to work, and I really think that there are a lot of teachers in this system who have gotten by without working. They are not going to support more stringent requirements. Not in any way, shape, or form.

The five science teachers cooperate fairly well, exchanging materials and ideas. They form one department of the school, chaired by the physics teacher. Recently, a reduction in force required the termination of the earth science teacher (the one with the lowest seniority). Unfortunately, a biology teacher was reassigned to earth science and a coach (with a minor in biology) was given the biology classes. The case study teacher, the senior biologist, felt that this decision was counter-productive, since the coach was poorly prepared and uninterested in biology. He and the other science teachers were bitter that the administration was willing to sacrifice quality preparation and instruction in science in order to keep a coach employed. His complaint about the emphasis on athletics is echoed by many teachers.

> In this school, we are athletically oriented, although we never seem to achieve anything athletically. Anyway, I have been told that I cannot take a field trip twice, because I am not to take the kids out of other classes. Yet, students can miss every other day for baseball. When the baseball season strikes, you might as well forget any player in your last period class because every other day he is gone. Every other day the girl golfers are gone, the boy golfers, boys' and girls' track, no sweat. But I can't take my kids on a field trip twice a semester. And the reason is because I am taking them out of class too often.

The school's fairly rigorous grading system is generally used by teachers in the science department. However, as the case study teacher explains, high standards may lead to low enrollments in one's classes.

> Mom and Dad don't want their kids to work too hard. I have had people tell me that I am a super teacher, but that I assign too much work. Mom and Dad don't want the kids learning, but they sure want the "A." Now, I am not talking about all parents, but a lot of them. The teachers that hand out easy grades are the ones that parents want their kids to get. You have kids in college that don't want to sign up for this particular course because the professor is too hard; well, we have the same thing going on in the high school. They will actually drop a class so they can get the teacher they want another time. They will wait until the next semester and sign up for it, or even the next year — whenever they can get the easy teacher. It's scary.
>
> You have to refrain from thinking about it. You have to build a shield and crawl into a little shell and just try to do your best. That is why I think the only way we are going to survive, and I mean this seriously, is with the individual teacher. I don't care what administration you have, or what community you are in, it is the individual teacher that is going to make it work. If that teacher wants to get by with as little as possible, that is exactly what is going to happen. There is nobody who can get rid of a teacher.

As teachers become increasingly concerned about declining enrollments, leading at best to two and three different teaching preparations and at worst to reassignment or to unemployment, they may waiver on high standards which may lead to lower enrollments in their classes.

The school under consideration is a first class high school, accredited by the North Central Association of Colleges and Secondary Schools. It is a general high school, which prepares plumber apprentices as well as engineers. As in many small, midwestern towns, the high school, with its athletic teams as well as dramatic and musical clubs, is the social focus of the community. Founded 113 years ago, the school has many traditions. Supported by its rich, historical tradition and its central position in the community, this school exemplifies public education in America.

III. THE SCIENCE CLASSROOM

The biology classroom of the case study teacher is a delightful place. A true learning environment, it is filled with commerical equipment as well as class projects which visually stimulate even the most casual onlooker or bored student. Wandering around this room, a visitor is tempted to ask, "What is this?...How does it work?...Do you use it in class?" One of the most interesting objects is a large, complete ungulate skeleton. The teacher found a dead cow, boiled the carcass, and with volunteer students reconstructed the skeleton. Another is a large topographic map of the bottom of a nearby lake, carefully surveyed and measured by a succession of advanced biology students who have described its ecological succession for over ten years. Others include a myriad of commercial materials - growth control chambers, incubators, microscopes, and models. Among all of these, one notices student experiments with Drosophila, mice, plants, etc. In spite of all these learning materials, the large room is orderly, and one senses that although everything is used, everything has a place.

The laboratory has a teacher's desk and demonstration table which face 30 movable, arm desks. These are surrounded by laboratory tables, each of which has gas, water and electricity. The laboratory is circumscribed by storage benches and hanging storage cabinets. It connects to a large stock room and another structurally identical biology laboratory. One only needs to glance into this adjacent lab to realize the difference in quality of instruction which occurs in these two rooms. One is an exciting learning environment, stocked and maintained by a dedicated professional, while the other is a spacious, bare classroom, used by an uninterested or incompetent, reassigned teacher.

The case study classroom reveals much about the instructor's interests, teaching, and personality. Although all of the science facilities are outstanding, his room is stimulating. It would require a lot of boredom or pseudo- sophistication to thwart one's natural curiosity about the displays, materials, organisms, and equipment in this room.

IV. THE SCIENCE TEACHER

The case study teacher is a master teacher in every sense of that term. Interested in adolescents, knowledgeable in biology, active in the community, experienced in teaching, recently he has experienced frustration with teaching. The following excerpts from an interview describe his feelings.

> Kids ask, 'Why try? I'm going to be passed on. I don't have to work.' When I get good kids, they're not going to work because they are going to be passed on....They are going to be given A's; no matter how poorly they perform, they are still going to get the A's. They divide their grades: A+, A, A-, A--. Then the kids come to the high school, and it is just a struggle.
>
> The following statement has been made by a middle school principal, at the begining of the year. I quote: 'We will *not* retain anyone!' That's what the teachers are being told. That is a quote. How can a kid operate after three years of that? Of course, the problem begins in the elementary schools; my wife faces this. She's got kids in the 4th grade who cannot read, and she wants them to be retained. Mom and Dad say, 'No, they are too big, etc.'. You know how that goes, so these kids get up to middle school. Now, for three years they have got it made because they don't have to do anything. They won't flunk - straight on down the line. They will pass them on, and so now where are they? They have reached 8th grade graduation, they can't read, they can't figure math, and we are suppose to take them and do something with them. It's too late.

Question: I want to get into science. What kinds of science have they had in the middle school year?

> This really varies; it is really a mess. But they probably have had at least a minimum of one semester of health. They have had, according to plan, one semester of science at the 6th grade level, a year of science at the 7th grade level, and a year of science in the 8th grade level. In two different schools you've got two different programs and nobody coordinates them. Now, what does that science consist of? You have someone showing films four out of five days a week. You've got one group that is big on the environment. What do they do? They go pick up trash, put pictures in the paper, and make posters and stuff for Ecology Week. They don't require them to read. You get everything in those classes, but what it amounts to is that you get nothing. In one middle school, students change teachers every 6 weeks. And the other middle school is going to go to that soon.

Question: Sort of a modular teacher in science?

Yes, it amounts to so little of anything. Kids that have had chemistry can't begin to tell me what an atom is; they don't know what a graduated cylinder is, which is one of the first things that we use. Metrics, you have to begin from the scratch. They are constantly telling me, 'Hey, I don't have to know this stuff, I'm going to pass.'

Question: Have the basic skills really deteriorated? For example, you have taught about 15 years, what has happened in that time?

I can honestly say that they have. I can look back on my records and see what I taught 10 years ago. I was teaching freshmen BSCS Yellow Version, first edition; now I am teaching the 4th edition. Basically, I could not begin to cover with these freshmen the content I covered 10-15 years ago.

Question: That is what a colleague at Purdue maintains. He cannot teach his freshmen in college now what he was teaching good sophomores in high school 10 years ago.

I agree with that 100%. That is the pathetic part. And, it's still the lack of reading and math skills. They've got so much other stuff to do at the elementary level as well as middle school level that they don't have any time to put in any reading. They are not required to do any reading or to do any math.

Question: So you get them in high school and you are trying to teach a discipline-oriented course. What happens?

You give them assignments to read, and they can't read them. Never before have I had complaints about my language.

Question: Yes, when I asked your students, 'What do you like best and what do you like least about your teacher?' one of them said the only thing she could think of was that you used words that she didn't know.

The last 5 years this has been a problem. I have to go back and revise some of the ways I teach and some of my questions because the questions incorporate terminology such as basic definitions. If they don't understand the terminology, they cannot answer. They don't even know what I am asking.

Yet, in spite of his growing frustraton, he is proud to be a teacher.

Question: What is the reason people like you and [some other teachers] stay in teaching? If I get a good student teacher, the chances I have of getting him or her to stay in teaching are slim. I am going to send you a good young man next year, who is teaching by default. He wanted to be a vet, but I think he knows he will never get into vet school.

Teaching is a profession. I can walk down the street and feel proud that I am a teacher. I think anything we can do as educators to put a feather in our cap; to say, 'hey, this is a proud profession,' is important. Let's build it up and speak positively about it.

This teacher has a remarkable record of encouraging girls to continue in science. Because he is the only teacher fully assigned to introductory biology, a prerequisite for both chemistry and physics, one can assume that his attitudes and actions influence later enrollment decisions. The percentages of girls enrolled in those classes is very high: 50% in introductory chemistry, 40% in advanced chemistry, and 47% in introductory physics. During the spring of 1983, these were the only advanced classes offered. When he was asked to explain his success in retaining girls in science, He said that he had not made any conscious efforts.

Question: Let's move on to girls in science. You really don't have a good administration and probably not good parental support, yet you and this science department have an excellent record of keeping girls enrolled in science. Do you have any idea of what you are doing right?

> No, since you have brought this to my attention the last several years, I have certainly thought about it. The only thing that I can see that I have done on purpose - and I have done this from the first day I started teaching - is to be fair. I don't really care who does what, what your name is, or if you're a boy or girl. I really try not to look at records of individuals, academically or otherwise. Whatever I say goes; once I make a rule it goes and it goes for everyone. I think my discipline has gained because of that.

His words as well as classroom observations suggest that hia success in encouraging girls stems from the total lack of sexism in his teaching. All students are treated equally; he does not tolerate sexist comments or humor; and he expects excellence from girls as well as boys.

He extends his teaching beyond the classroom door, developing and/or maintaining important natural resources which will enrich the lives of the townsfolk. He serves on the county park board. He has developed over 61 acres of land surrounding the new high school into a nature area. Forty-five acres have been developed by the case study teacher and his students into a wildlife refuge which includes a nature trail with identified species, ponds, and streams. It serves as a bird and wildlife sanctuary. He obtained and planted over 6000 trees from the State Nursery.

In addition, he has developed a field-trip program to a nearby lake in which approximately 70 students are involved annually. They have saved the only natural lake in the county by carefully recording changes in abiotic and biotic factors. In addition, they have mapped the lake bottom and produced a brochure concerning it for the community. Last, he has been instrumental in preserving a nearby area for a wild-life refuge. The teacher and his students developed a proposal and presented it to the mayor; as a result a new local wildlife refuge was founded.

Biology education, for this educator, means improving the quality of the environment for all citizens in his community. Some of his projects, however, have not won administrative support or approval. For example, an advanced biology project to assess pollution in a local river (the source of the city's water supply) by controlled bacterial experiments was quickly stopped by the school's administration when the results suggested commercial pollution. Understandably, some of his teaching frustration comes from lack of administrative support.

In conclusion, a quotation from this teacher's invited comments in New Directions in Biology Education, 1981, Hickman, F. & J.B. Kahle (eds), Reston, VA: National Association of Biology Teachers describes his teaching philosophy.

> Apathy is defined as a lack of interest; a listless condition; indifference. We in education experience apathy each day as we attempt to sell our products to uninterested buyers. Why don't they care? Why aren't they interested in what we are selling? Could it be that we are selling a useless product? Could it also be that many of the leaders of our churches, our government, our schools, and, yes, even our own parents are the products of outdated and useless information? In this exciting age of discovery and development, is the public capable of coping with the many new finds of science?
>
> Our past has shown problems in how we educate our young. We have found that education cannot limit itself to facts, but must nurture the ability of students to make choices based on sound values. The apathy in the classroom may be the result of our attempts to dispense outdated, worn-out, and overused information that no longer supplies an individual with the tools needed to make choices based on values.

> Today we have no greater challenge than to deal honestly and clearly with the multitude of biological advances made in the past few years. We must, however, always remember that the individual, when faced with indecision, must finally make the choice. Only when an individual can deal with the consequences of a decision can he or she be considered truly educated.

The students and citizens of this Midwestern community are, indeed, fortunate to have a biology teacher of such calibre. In addition to encouraging young women, he inspires all who will listen.

V. THE CASE STUDY STUDENTS

The students at the case study high school are typically white, middle class, conservatives. They are smartly dressed, reflecting the rather strict dress code of the school. Introductory biology is taught at the ninth grade level, so the observed students were 14 and 15 year olds. Sitting in the back of the classroom, an observer can quickly identify the dominant social groups, found in any public school which serves a cross-section of the population. The popular girls are distinguished by too much make-up, coordinated sweaters and skirts, and a proclivity for sitting near the rear of the room. They are sur- rounded by the larger, more mature-appearing boys, clad in polo shirts, jeans, and expensive running shoes. These are the jocks, and together these two groups have the highest status in the school and in the class. Near the front of the classroom are the smaller boys — just entering puberty — and the serious girls. These two groups have little to do with each other or with the "cheerleaders" and "jocks." Rather, they giggle appreciatively when a member of one of the two status groups says something humorous or clever, and they squirm in their seats, if the teacher focuses too much attention on one of them.

Interviews with students enrolled in introductory biology revealed several commonalities. For example, they all liked the laboratories best. Although most lab groups consisted of four students, one girl, who was observed working with another student (boy), was asked about her group. She stated that the two of them elected to leave larger groups and work together because they could get more done. It was observed that these two were very serious students, plainly dressed, and socially isolated. This girl wanted to become a veterinarian and was serious about her biology studies. She had been encouraged in her career choice by her mother and an older brother (a mechanic), but not by her father. Unfortunately and unrealistically, although she planned to take 3 years of science, she was enrolled in general math and did not expect to take algebra or other college preparatory mathematics courses.

Several students mentioned that they enjoyed discussing biosocial or bioethical topics in class. (One observed class session involved a lesson on birth defects and related issues.) Uniformly and impressively, they noted that they considered all sides of an issue in biology class. The following exchange is typical of their responses.

Question: Do you like those classes?

> I like to know about those things [biosocial issues]. And in biology class, they tell you a little bit more about what is involved than they do in the papers.

Question: Is there any way what you learn in biology differs from what you learn in the paper?

> Well, in the paper they only tell you the main parts of the story; or, at least, what they think is the main part of the story. Here you may think different. They may leave a certain part out that you think is important.

Other commonalities involved rather naive opinions about work or careers. When asked what they planned to do, the students all mentioned professional careers, veterinarian, social worker, psychiatrist, actress. However, when asked what they would probably be, their aspirations faltered, and their responses changed to a hospital aide, baker, secretary. In addition to the student noted earlier, they were naive about the importance of math as a preparation for most careers.

All girls interviewed were confident that they could combine a professional career with marriage and children, although some noted they would work less when their children were young. When one was asked to explain her confidence on this point, she replied that she knew she could do it because her mother (a substitute teacher) did. She demonstrated a striking naivete about the real world of work.

Only one student interviewed expressed realistic views concerning preparation for a career and possible future roles. One girl, who hoped to be a psychiatrist, spoke knowledgeably about her future course selections, including mathematics. She knew that she would have to plan carefully and work hard to successfully combine a profession with a home life. Yet, she was confident that she could. When queried about her beliefs, it became obvious that she had a role model and mentor, a woman psychiatrist who was raising a family alone and who was her friend. The student was familiar with the woman's professional and home life and had, therefore, developed more realistic attitudes. The striking contrast between this young woman's expectations and those of the others vividly demonstrated the importance of a role model. Because of academic preparation alone, she is the only student interviewed who even has a chance of achieving her goals.

The students all voiced positive feelings about the quality of men and women scientists, but with probing, doubts about women's abilities were expressed, as the followng excerpts show.

Question: So you think both men and women can be equally good as scientists?

Well, yeah, but men are probably better.

Question: Would you trust the work done by men and women scientists equally?

I am sure a female can do things just as good as a man.

Question: There has never been anything in your life that says, 'you can't do it because you are not a boy?'

Well, I can't play baseball.

Although she laughed about her response, the interviewer wondered why this girl could not play baseball. Were there rigid social mores in the community which continued to discourage girls from Little League and other athletic opportunities?

The students all liked biology, the teacher, and school. Indeed, school was the focus of their lives. As they struggled for personal acceptance by their peers, one hoped that they would not lose sight of the professional goals they espoused. In addition, one hoped for improvement in the inadequate guidance and counseling systems that permeate financially pressed public schools. Without more and better counseling, science and math enrollments will not increase. This typical high school, in spite of superb facilities and professional, dedicated teachers, will not produce more students prepared to enter scientific and technical fields unless the need for basic literacy in science and mathematics is recognized and remediated.

VI. STUDENT/TEACHER INTERACTIONS: CLASSROOM OBSERVATIONS

Classroom observations were made during the late spring of 1983; both introductory and advanced biology classes were observed. Prior to observation, course syllabi were inspected and the text was analyzed for possible sex bias. The syllabus for the introductory course presented course goals, description, outline, and skills. It was written in general terms, appropriate for all students. The following is the course description.

> This course is an introductory biology program designed to help students learn how to learn as they incorporate factual information into a self-constructed framework of reflection and analysis. Students will be committed to laboratory work with concomitant hypothesis formation, experimental design, collection of data, and interpretation of findings.
>
> This course is designed to enrich the students' life today and to prepare them for coping with the challenges of tomorrow.

The syllabus for advanced biology stressed laboratory activities and in-depth study in selected areas of biology. Perhaps, it was an older outline, because it contained typical sexist language. Examples include the following ones.

- ..problems facing *man's* existence
- ..to the limits of *his* ability
- ..to control *his* environment

Observation I

On Monday, March 11, 1983 an advanced biology class was observed; the lesson was the beginning of the human reproduction unit. Eleven males and four females were in the class. The preceding Friday, each student had been handed a preserved frog and instructed to care for it as they would a child for the next 48 hours. That is, they were to "take it to practice" or "hire a babysitter." In general they had to schedule their lives around that of their "child." The case study teacher opened the class with the question, "What did you think?"

Girl: Made me think about the reality of having a kid.

Boy: Lots of responsibility; gives a sense of responsibility.

Teacher: What did your parents, peers, and others think?

Girl: Mother jumped and refused to have it in the kitchen.

Boy: It brought attention for a while; then it wore off and was no fun.

Boy: I took it to the library. The librarian leaped and, then, said she shouldn't have.

Teacher: How many of you got rid of it - at least temporarily?

All hands went up in positive response.

Next, the teacher compared their feelings of frustration with the inconvenient, smelly frog to those adults who may experience caring for an unusual child. He led the discussion into a consideration of human birth abnormalities and their bioethical considerations, quoting from newspapers and a report of the Presidential Commission for the Study of Ethical Problems in Biomedical & Behavioral Research.

After this introduction he presented a short, factual lecture which included: trisomy, euthanasia, relationship of premature births and mothers under age 18, Baby Doe controversy, and "undervaluing the lives of the handicapped." When he paused to ask for questions, 6 males and 2 females responded. Their responses included:

Boy: Clarification of Commission ruling

Girl: The frog represented the problems of a handicapped kid.

Boy: What is the purpose of life?

Boy: Parents have a right to live, too.

Boy: What about adoption?

Girl: Although there were lots of us with frogs, parents may be alone with a handicapped child.

The class closed with a general discussion. It was interesting to note that many students related their mother's reactions about the frog, but none mentioned his/her father's response. When asked, one remarked, "Dad didn't make any comment." It is difficult to know if the focus on their mother's reactions is due to a social expectation of female repugnance or to the lack of involvement on the part of their fathers.

Observation II

On March 11, 1983 an introductory biology class was observed also; there were 13 boys and 14 girls in the class. The lesson concerned sexual reproduction and involved reviewing a test. The atmosphere was relaxed, quiet and controlled; there was good-natured kidding between the students and the teacher. In addition to the stated purpose of "checking the machine grading," the teacher used the factual review of Animal Structure/Function: Reproduction to introduce human sexual information. For example, he described a vasectomy, after only 11 males and 1 female responded that they knew what one was. He discussed human fertilization, and explained a tubal ligation. The latter was in response to a girl's question about one.

Girl: My mom has never come out and said the whole word. She just says, 'tubular.' What is it?

The case study teacher used standard side-view diagrams of human reproductive systems and asked straightforward, factual questions, but he covered pertinent points about human birth control very well.

The class continued with a pretest, used both to assess basic knowledge and prevalent superstitions concerning human heredity, the next unit of study. The test consisted of common statements such as "The father determines the sex of the child" to which students responded "yes" or "no." Tallies were taken and items were discussed. The next day, the case study teacher presented the responses of all classes (in percents) to demonstrate mathematics in data collection, to compare among classes, and to contrast between current and past students.

In the class observed, the three items which received the most incorrect responses were the following ones.

> Males are biologically stronger than females. (yes: 9 boys, 11 girls)
>
> The total number of male births exceeds female births each year. (no: 10 boys, 6 girls)
>
> Certain acquired characteristics such as mechanical or mathematical skills may be inherited. (yes: 4 boys, 6 girls)

Generally over 50% of all his students responded incorrectly to the above three items as well as to the following ones.

> Children born to older parents usually lack the vitality of those born to younger parents.
>
> Certain hereditary characteristics are influenced by the blood.

The lesson concluded with a general discussion of superstitions or "wives tales" in heredity. Obviously, many students believed them and held typically stereotypic views concerning male and female roles in heredity.

Observation III

On May 2, 1983 a laboratory period in introductory biology was observed. Although the teacher interacted well with all students, it was noted that he paused and waited for a male to respond, but that he prompted a female. However, those are isolated examples; generally no differences in his treatment of boys and girls could be detected.

The students selected their own lab group and worked at tables that have four stations. The distribution of the students followed the following pattern.

Table 1	4 girls
Table 2	4 boys
Table 3	1 girl, 1 boy
Table 4	3 girls, 1 boy
Table 5	empty
Table 6	4 boys
Table 7	3 boys
Table 8	5 girls

The following interactions were noted.

Table 4 (3 girls, 1 boy)
Boy was setting up experiment, asking for equipment and help (in the best TV medical style). For example, "Where's the thumbtack?" "Cut here."
Girls were reading text and answering written lab questions.
When asked how their group was formed, one girl replied, "We picked Steve because we wanted him to help us do our frogs." (Giggles)
"Steve, how did you like that?"
"It was ok." (More giggles)

Table 3 (1 girl, 1 boy)
Boy joined girl (vet aspirant discussed earlier) because he was "goofing off" at Table 2 (4 boys)

Table 2 (4 boys)
Interestingly this was the only table (with over 2 people) where students worked in pairs. At other tables, one person did the lab and the rest watched.

In general, in spite of a sensitive teacher, sex roles seem to influence what is happening in this laboratory. The students generally "act out" the roles assigned to them by society.

VII. TEXTBOOK ASSESSMENT

The text used by the introductory biology students was Living Systems, Oram, R.F., Hummer, P.J., & Smoot, R.C., Columbus, OH: Charles W. Merrill & Co., 1981. Although women were equally represented in photographs and illustrations, they were grossly underrepresented in more substantive ways. For example, only 22 works by female authors were cited, a 1:10 ratio to male authors. In addition, there were no illustrations of famous women scientists. Women representatives of various ethnic or racial groups (native) were portrayed as well as women patients, nurses, nutritionists, and laboratory technicians. Two photos illustrated women in atypical positions: a line crew telephone person and a television film editor. Sexist language was used; that is, masculine pronouns were used in reference to scientists and man was used in a generic way to indicate humans. Generally, the text depicted the role of women in science in a token way by using them in illustrations rather than by describing their work and contributions to scientific research.

Case Study C

Ann Haley-Oliphant
Maineville, Ohio

I. THE COMMUNITY

This case study was conducted at a high school located in the Midwest. The school district is one of the largest (in terms of geographic area) in the county. There are approximately 21,000 students within the district. In enrollment, the district ranks first in the county and fourth in the state. The district has 18 elementary schools, 5 junior high schools, and 4 high schools.

The school district has a AAA rating from the State Department of Education. All of the senior high schools are fully accredited by the North Central Association of Colleges and Secondary Schools. In addition, the senior high was selected as one of the five most outstanding high schools in the state of Missouri this year.

The tax base for the district for the 1982-83 school year is $5.62 per $100 of assessed property valuation. The total assessed valuation within the district is approximately $778 million, which amounts to an estimated assessed valuation per pupil of $35,500. The heaviest burden of the taxes falls on the residents or patrons of the school district; for there is really no industrial base to consider.

The population of the three communities involved is approximately 150,000. The communities are basically non-industrial and parents are primarily employed in professional and managerial positions. According to one of the school counselors,

> By reputation, the [school district] is considered to be in an affluent area. There is a large amount of variation in average salaries of the families but I would say the average is probably around $40,000-$50,000 per year.

The community consists of a mixture of religions (Protestant, Catholic, Jewish). There is no one predominant form of religion. In terms of ethnic groups, the senior high school consists of 95.9% white, 1.4% black, 2% Asian, and 0.7% Hispanic. The primary language spoken is English.

The cultural, recreational, and higher educational opportunities available to the students in the school district encompass the extensive array of institutions found in the city's metropolitan area, such as a large zoo, a botanical garden, an art museum, a museum of science and natural history, and several well-known universities. The district has several cooperative programs with the area universities in which students may earn college credits while still in high school; participate in artistic, theatrical, and musical events associated with the colleges; and perform scientific research during the summer at various institutions.

According to the counselor,

> The community support is extremely good and is one of the strengths of the whole system. Anytime a bond issue or tax levy [has been] before the public and the school promotes it — it has been supported.

There are many parent volunteers who work in all phases of the school program.

The school board is comprised of three females and three male members. All school board meetings are open to the public by state law, except when there is an executive session. There is a Citizens' Advisory Council which provides counsel, advice, and recommendations to the Board. This council consists of four members — three are parents of current students.

II. THE SCHOOL

The senior high school has 1581 students in the tenth through twelfth grades. Approximately 70% of the students have outside employment. The school maintains one of the highest daily attendance ratings (95% ADA) in the area. In addition, there is very little vandalism, graffiti, or other instances of destroying school property. The philosophy of the school may promote excellent attendance and low vandalism. As the counselor explains,

> There is no student handbook. We believe that if you set down rules and regulations you are laying a base for a minimum performance. So, everyone will achieve the lower end. We expect the best at all times....Responsibility is something we key in on. We believe dignity dictates behavior. Most student handbooks are so negative. This is not the attitude we are trying to foster. We are trying to give the students the opportunity to succeed and go beyond the minimal expectations. [The lack of vandalism] is not because they are heavily supervised, but because they are not supervised. No one is on hall duty. The students have the attitude of being not renters, but owners [of their school].

In terms of the teachers and their relationships with the students, the average class size is based on a 19 student to 1 teacher ratio. The teachers make themselves available to the students before and after school and during the weekends. According to the counselor,

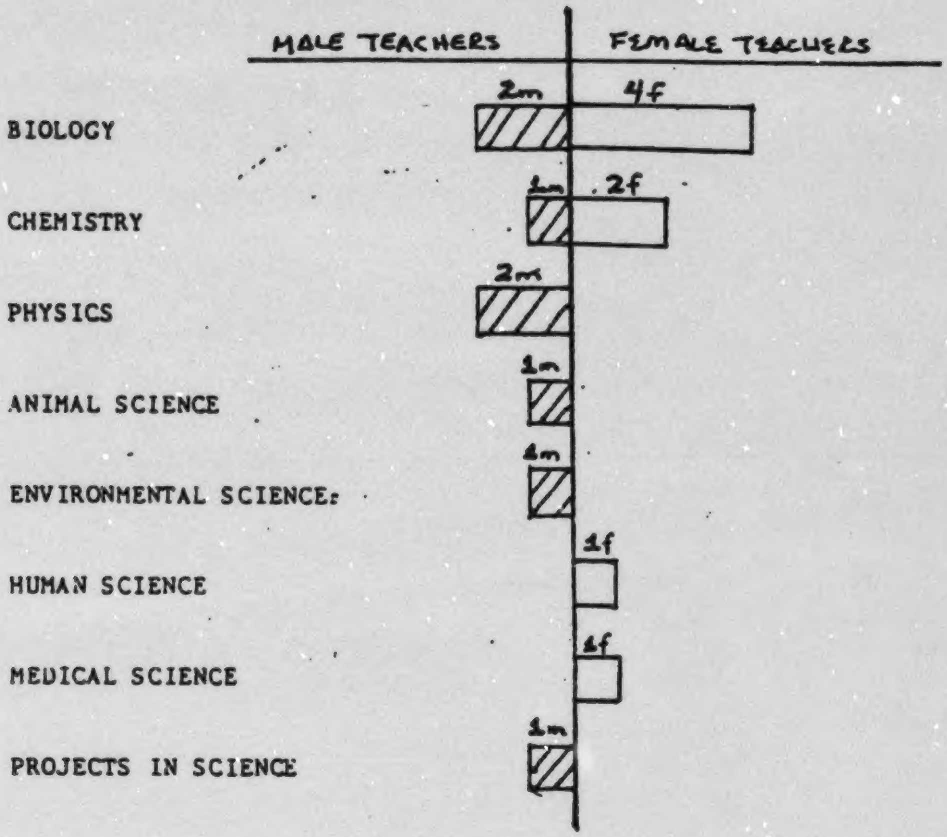
> The students appreciate the give time the teachers make available to them. For example, one of our chemistry teachers, is here frequently on Saturdays with her advanced placement chemistry students doing extra demonstrations, labs, etc.

The teachers have one 55-minute preparation period each day and are extensively involved in voluntary extracurricular activities.

Students are involved in many community service projects, such as biannual blood drives, canned food drives, sandbagging during recent floods, volunteer service for senior citizens, and entertaining at hospitals and retirement facilities. In addition, there are 11 athletic teams for both girls and boys.

The science department consists of nine full-time and two part-time instructors. There are five female and six male members on the science faculty with the department chairperson being male. The science coordinator for the entire district is a female. As Table 1 shows, the biology and chemistry courses are taught predominantly by women (67%); whereas, the physics courses are taught exclusively by men (100%).

TABLE 1. The number of teachers by sex teaching the science courses.



In the biology and related life-science courses, (animal, environmental, human, and medical sciences) girls comprise 49% of the enrolled students. Likewise, girls compose 49% of the total student population in chemistry. However, only 28% of the students enrolled in physics are girls as shown in Table 2. Overall, females make up 46% of the total number of science students according to the data displayed in Table 3.

Although the female enrollment is low in physics, it is comparable to that reported in other studies (Ferry, 1982). However, the chemistry enrollment of 49% female is impressive. The following factors may be involved in the enrollment figures of girls in science courses at the school:

1. Sixty-seven percent of the biology and chemistry courses are taught by women, who may be acting as role models.

2. The attitude of the guidance counselors towards girls in science courses. The counselor explains,"As an outspoken female personality, I have always felt that girls should have every opportunity available to them and never thought in terms of male occupations and female occupations. I don't think we have ever been guilty of a girl coming in [who] is good in science and saying 'Why don't you be a nurse?' Instead we will think 'Why don't you be a doctor?' There is no reason a girl should fit into a typical female occupation. We have encouraged all kinds of occupations without regard to sex."

3. Both the educational level of the parents and their expectations for their daughters are high. The counselor said, "Parents are cognizant and aware of the opportunities. Many of them feel these opportunities were not available to them when they were young so they want to make sure their daughter does not miss out." The cae study biology teacher, adds, "These parents are achievers. They read all the magazines and see where the money is being made and that these are the careers of the future. [They will say,] 'You [their daughter or son] should go into this'..."

III. THE SCIENCE CLASSROOM

The biology course at the senior high is designed for 10th graders and emphasizes many ongoing social issues through the use of PAKS. The case study teacher, describes it in the following way.

> We teach biology as a survey course. We tie in what is going on in everyday life with the main topics of ecology, the cell, genetics/reproduction/development and diversity of life.

Table 2. The enrollment of students in science courses during the 1982-83 school year at the senior high case study school.

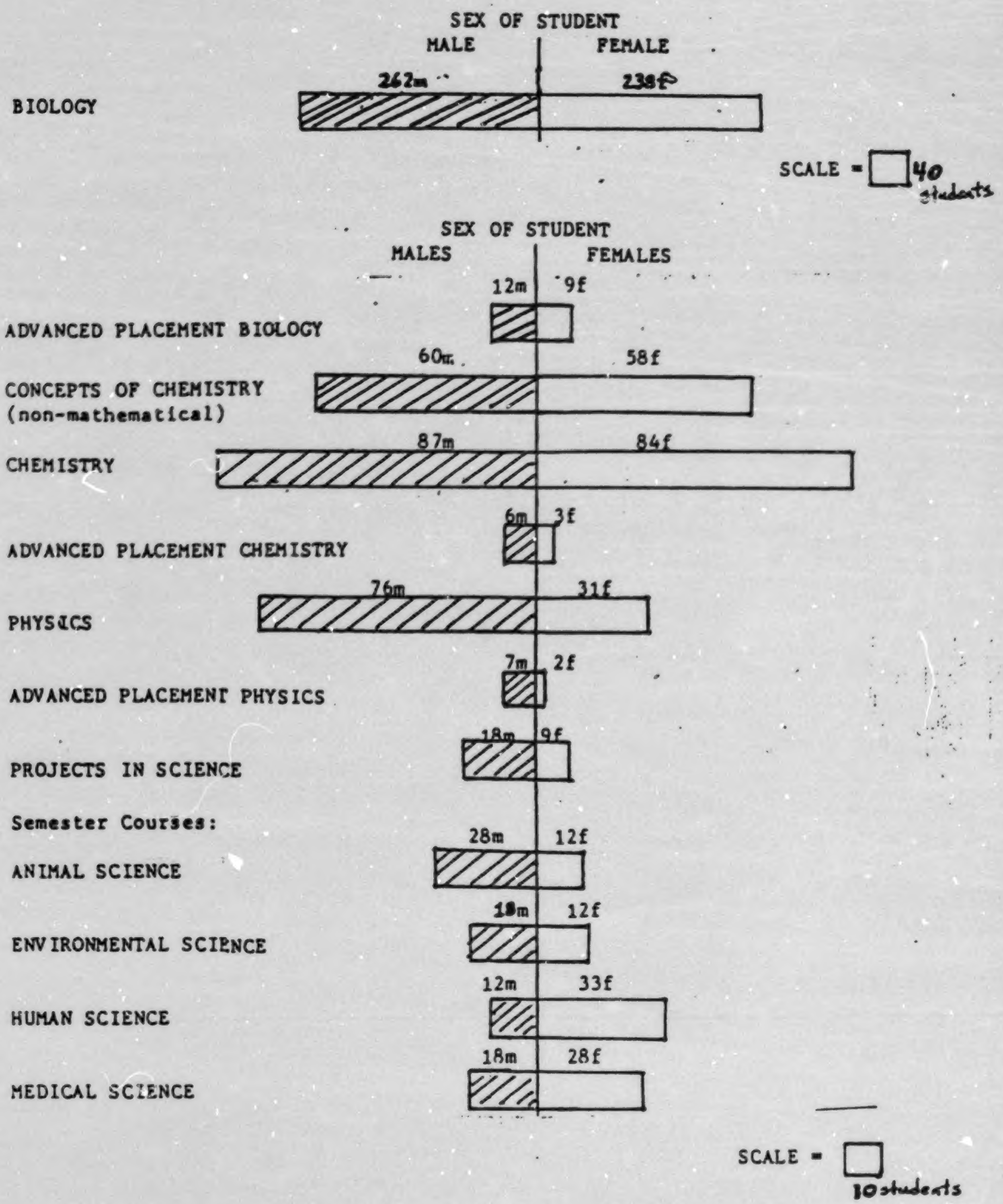
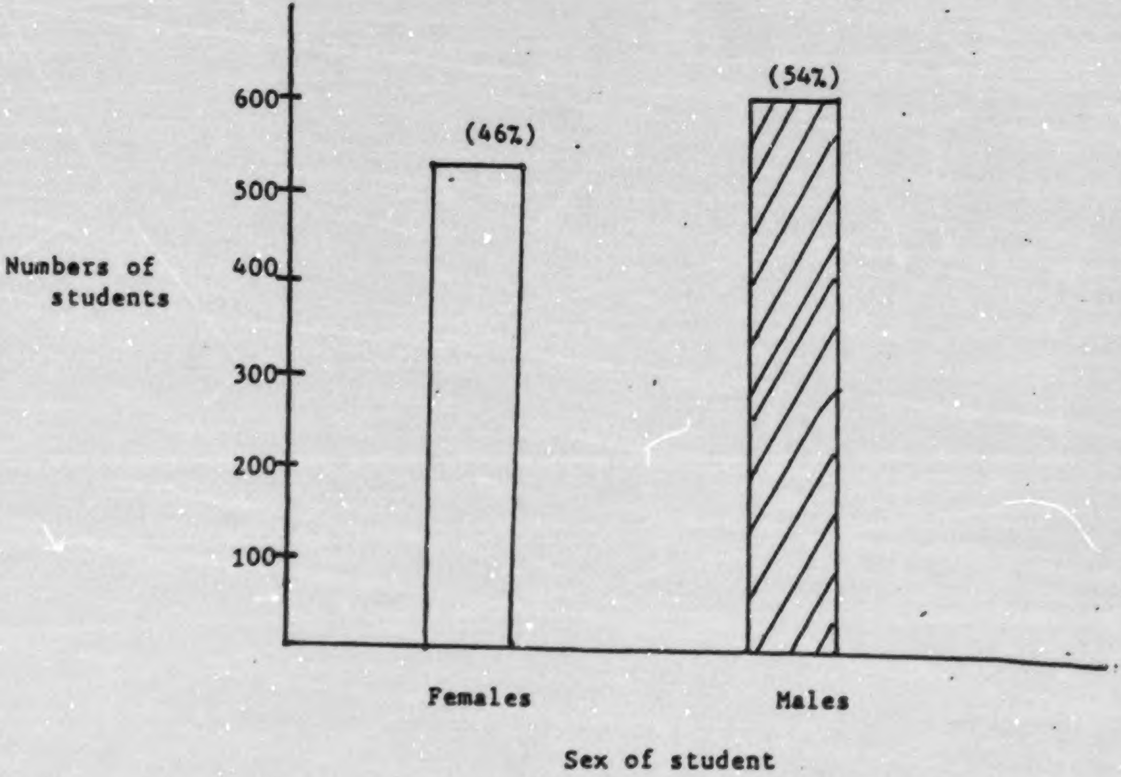


Table 3. Comparison of the total number of female to male science students during the 1982-83 school year.



The PAKS are individual packets covering particular topics through the use of classroom discussions, lab experiments, audio-visual aids, field trips, debates, and other experiences. Each PAK centers around a particular social issue such as:

> What does the word 'cancer' mean to you?
>
> Should society regulate your ability to reproduce if you have a genetic disease?
>
> Should cigarettes, alcohol, and other harmful drugs be declared illegal?

At the end of each PAK, the students are given the opportunity to voice their opinion about the particular issue. As the teacher explains,

> We make a point of not giving our own opinions. We give them the social issue, the pros and cons, and then they can decide for themselves.

The method of evaluating the performance of the biology students is through the use of unit examinations (primarily multiple choice items), quizzes, and lab reports. There seem to be many opportunities to earn extra credit and do independent projects.

The physical arrangement of the classroom and laboratory are depicted in Figures 1 and 2. There were few exhibits, displays or special equipment visibly apparent in the classroom and laboratory. Several posters of wildflowers and animals decorated the walls of the classroom. A few scientific models were present in the front of the classroom. Notices of short courses, college curricula, special symposia, and current events were placed on the door entering into the classroom. The laboratory can be used by two biology classes at any one time. The tables are fixed in place. There is only one poster decorating the laboratory. Aquaria, animals, plants and any other stimulatory items were not found in the classroom or laboratory.

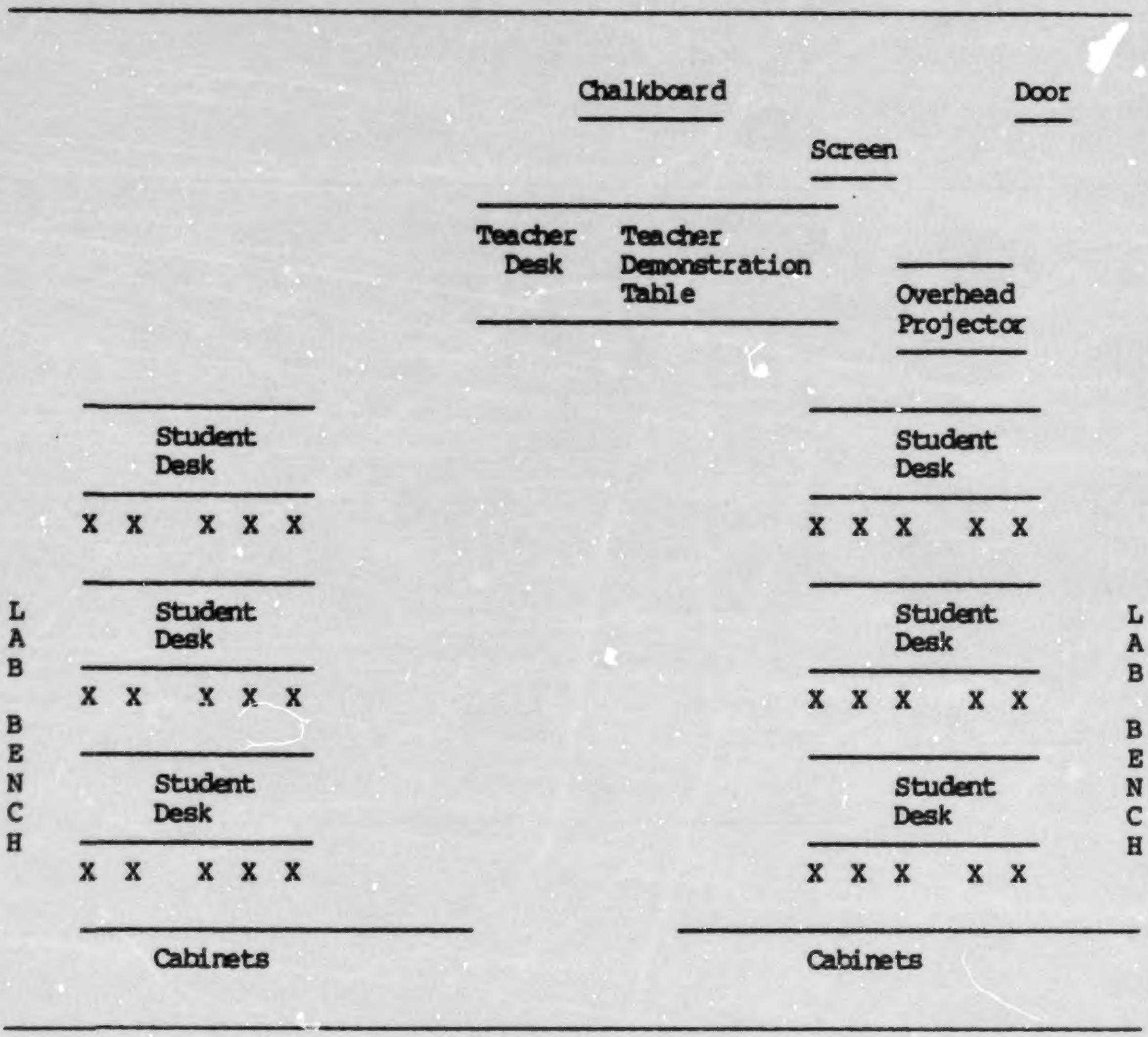

Chalkboard
Door
Screen
Teacher Desk
Teacher Demonstration Table
Overhead Projector
Student Desk
X X X X X
Student Desk
X X X X X
Student Desk
X X X X X
Student Desk
X X X X X
Student Desk
X X X X X
Student Desk
X X X X X
LAB BENCH
LAB BENCH
Cabinets
Cabinets

Figure 1. Biology classroom of case study teacher.

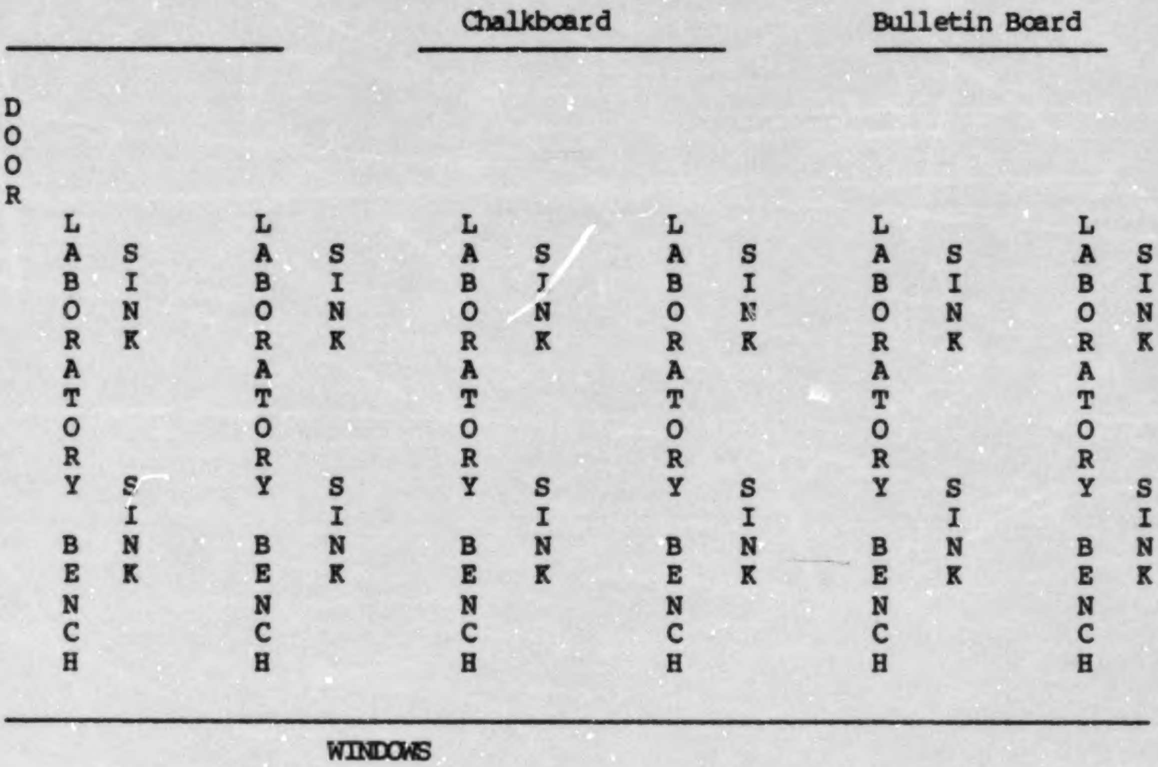

Chalkboard
Bulletin Board
DOOR
LABORATORY BENCH
SINK
SINK
LABORATORY BENCH
SINK
SINK
LABORATORY BENCH
SINK
SINK
LABORATORY BENCH
SINK
SINK
LABORATORY BENCH
SINK
SINK
LABORATORY BENCH
SINK
SINK
WINDOWS

Figure 2. The laboratory facility at the senior high school.

IV. THE SCIENCE TEACHER

The case study teacher described two teachers who encouraged her in science by saying, "They were well prepared and were very positive." Likewise, several of the students interviewed describe the case study teacher in the following manner.

> [She] encourages everyone. She makes biology interesting, and she does it so well. She relates to the kids and talks with them or tells jokes. If you have a good teacher, you can get something out of a course.

In all of the student interviews, the girls remarked about how the biology class ties in everyday events which make the course seem more relevant. For example, one girl said,

> She gives us up-to-date information and relates it to how we are living today. She does not give us old stuff from the textbook.

Former students see her as a person who was "supportive and gave guidance in matters of everyday living as well as in a career choice."

The case study teacher was raised in a farming community in Indiana. She claims to have always liked science. Her uncle was one person she greatly admired:

> He was a physician, and he encouraged me a lot. If I had been in this group of young girls, I would have gone on into medicine. But teaching was more acceptable.

She earned her bachelor's and master's degrees at Purdue University. She has been involved in many inservice workshops at the case study school and may be doing a workshop this summer for the district's elementary teachers. She will be presenting simple lab techniques to the teachers.

This workshop focuses on what she feels is one of the crucial problems in science education. As she explains,

> Unfortunately many elementary teachers have little or no science preparation. They are afraid of science. If the teachers did know the simple techniques then we (high school teachers) could get on with more sophisticated things with students. So many of the elementary teachers are female and they push the science aside and develop the interest in English and history. If the interest had been encouraged at the younger level, more girls might be interested in science. So many times with little boys and girls in elementary school [I hear a student say] 'Oh, gee, what is this insect?' and the teacher reply 'Get that out of here. I don't want that thing near me.' The students quickly learn that if they want to get along with the teacher then they don't bring 'creepy, crawleys.' So the curiosity does not get developed unless there is someone at home or in school that can influence that interest.

In encouraging girls in science, she states that,:

> By the time they get to high school, some of them feel it is too late to begin in science. So I try to be very positive with them and tell them they have a lot of ability and to take more courses.

This encouragement is perceived by many of the girls interviewed. As one put it,

> [She] encourages us to take the next course up if we do well. She always encourages me to do science fair projects and extra readings. If you want to go into a science career, she tells you what classes you should take for a particular career.

Among the students interviewed there were mixed feelings about the PAKS. Some students really liked them while others preferred to use the text (Modern Biology). One female student said,

> I like the lab work. The PAKS are kind of boring with all the writing. Sometimes I don't feel stretched enough. I like how my instructor ties in current events and current research.

On the other hand, another female student, who is not interested in pursuing a scientific career, said:

> I like how she writes everything down — but sometimes it gets confusing and she needs to slow down and make sure we understand everything.

Other attributes of the case study teacher that may be encouraging girls include: the use of same sex groups in labs; not using comments that suggest sex-role stereotyping; not assigning clerical-type duties to just female students; encouragement of out-of-class science activities through her work with the Biology Club, science fairs, and independent projects; and her lack of sexist humor and remarks. In addition, several of the students noted her dependability, reliability, and positive attitude toward her students, plus her rapport with individual students.

One discouraging factor that surfaced during the case study was the segregation of students into lower mathematics and chemistry courses. Apparently, the school places students in math and chemistry courses depending on their achievement in prior courses. The teacher describes the process in the following way.:

> We place our biology students into the chemistry [courses] according to their ability in math and science at the tenth grade level. Two or three girls that I told to take 'Concepts of Chemistry' (non-mathematical) were so upset because they said, 'My father said I must take regular chemistry because this is where the jobs are. I don't want to go into science but this is where my parents say the jobs are.' Unfortunately, parents are pressuring them to go into areas they shouldn't and areas they aren't interested in.

When several students told her they signed up for regular chemistry, she asked them to change into 'Concepts of Chemistry.' She explained this action by saying,

> I told them they were not going to have any success and they would probably end up dropping back into 'Concepts.' This same situation has happened several times before.

There seems to be a genuine concern with the teachers in placing the students in the appropriate level of course, regardless of sex. However, during the student interviews the following comments surfaced:

> My math has not been that good. I have been in lower math courses. They (the school and teachers) stick you into courses.
>
> [The teacher] said science would not be a good thing for me to go into due to my math grade. My grades are below average in math but above average in biology. She said you need the two — good math and biology grades to do well in science. It was kind of depressing because you have to have both the math and science to get a really good job today. It hurts me scholastically compared to the other students. I don't think I'm getting as good of an education as other students and I think it will hurt how I get into college and a future job.

Is this "tracking" discouraging young women and men from becoming scientists? Isn't it true that Edison, Einstein and others did not do well in some of their course work? Is this trackng preventing students from getting into courses that are over their heads and being frustrated, or is it impairing their self-images and feelings of self-esteem? This entire issue needs to be addressed.

V. THE CASE STUDY STUDENTS

From the student interviews the following similarities were found.

1. They were interested in sporting activities for hobbies instead of an emphasis on needlecrafts, etc.
2. They all liked the labs best in the biology course.
3. Almost all of them mentioned their father or grandfather as being their role model:
    * My interest in science was sparked by my grandfather and my uncle. They are family practice doctors.
    * My father grew up on a farm. I've grown up with dogs and cats...that's why I might like to be a veternarian.
    * My dad told me about what he does and it sound interesting. (He builds and sells nursing homes.)
    * My dad had gotten me science packages to do and we'd do them together. We subscribed to them. The kits included fiber optics, sound, earthquakes. That was when I was in 3rd-5th grade. Then during 6th and 7th, we got a science magazine called Sci-Quest.
4. All of them felt comfortable about asking questions in class if they did not understand something, but most of them said that

they did not ask a lot of questions.

5. Most all of the students were unsure of their career plans.

6. All of them saw no reason as to why a woman could not be a scientist.

Many of the students interviewed felt that there had been very little discussion of scientific careers in the classroom. As one female student commented,

> Teachers should do more about science careers in science class. Maybe they should have a scientist come in and tell us what they do. The only way I know of scientists are the little old men in the white jackets. Scientists seem to be boring people.

Another female student voiced a similar opinion:

> I have never talked to or seen a scientist. I picture people sitting around a bunch of microscopes. That's a drawback for me, since I like to be around a lot of people. Another drawback is that if I don't find out about scientific careers, then I would say that I'm not going to take the chance [of pursuing a scientific career].

The following views were expressed during the interviews also:

> You never hear anything about women scientists — but there are a lot of women doctors — or more than there used to be.
>
> I would select a scientific career because I like lab work and trying to work toward finding something on my own. I like working with people but I also like to work by myself and relate to people my findings at a conference.
>
> More men are scientist than women. I do not think there will be more women scientists. Men seem dominant in some things. More men seem interested in science than women do.
>
> Women have a different viewpoint on things. You need both viewpoints (male and female). If men and women work together — they can do better.
>
> Men are scientists. It is a masculine job career. Women don't go into it because being a scientist will make them look bad.
>
> More men are in engineering. Women are in less complicated work.
>
> Women do the lab work and back-up work more than men. Men are out trying to cure things.
>
> I probably think there are more male scientists, since it is science and women think they aren't allowed in it.
>
> I don't know if it is women thinking scientists should be men, or men thinking scientists should be men.

> There are some women scientists; but men have been in it longer. Women can do the same job as men. They may have a different way of thinking and might improve science.
>
> I would like to be like Madam Curie, only not as much of a recluse as she was, finding something new and making up my own experiments. She applied it to different things and helped other people with it.

Even with these attitudes the girls still felt that a man and a woman would have to work equally hard to be a scientist; that there would not be a great deal of difficulty in having a family and being a female scientist; and finally, that there really is not a problem with women becoming scientists. For example, the young women interviewed described scientists in the following ways.

> There are different kinds of scientists. Some people go off and get grants and become hermits. Other people work with a lab partner and then there are others that do the same thing all the time, like blood technicians.
>
> Scientists are quiet people...all of them are smart...they all wear white coats and glasses...they do not work with people.
>
> A lot of scientists waste their time but most of them seem to know what they are doing — they try really hard to solve their problems and help everyone else.
>
> Scientists are intelligent people. They keep to themselves and always sit and study. They look for possible cures for diseases.

VI. TEACHER/STUDENT INTERACTIONS: CLASSROOM OBSERVATIONS

During the classroom observations, several interactions between the students and the case study teacher were noted. First, she asked many questions of the class, and she rarely selected people to answer the questions. Instead, the female students were the first to respond 44% of the time; whereas, the male students responded first only 31% of the time. The remaining questions were answered by more than two students at any one time. Second, girls requested further information about the topic being discussed more often than boys did; and girls, compared with boys, made more inquiries about their grades, quizzes, and homework requirements. There was no preferential treatment given to male or female students. In addition, there were no sex-role stereotypic comments, except for one remark on the lab day.

The instructor remarked to some of the girls that they did not need to redo their drawings "ten times."

VII. TEXTBOOK ASSESSMENT

Several texts and curricular materials have been evaluated in a quantitative format. The following discrepancies were found in the texts:

1. Career descriptions were only slightly addressed. Generally the careers were only discussed in terms of the activities of former scientists. Otherwise, the texts might include a picture of a female chemist but there would not be a description of the career.

2. The percentage of scientists being women in any one text was never more than 42%. Overall in the three texts examined, scientists were only depicted as women 23% of the time.

3. In general, women were not used in the illustrations of human anatomy, scientific principles, etc. The only sections depicting illustrations of women dealt with the reproductive structures, endocrine glands, medical abnormalities or a few genetic traits. Even in the two biology texts examined only 25% of the pictures/illustrations contained women (other than scientists).

4. Females were infrequently (18% or less) cited in bibliographies, indexes, and supplementary readings. Two of the textbooks had converted all of their supplementary readings listing to initialed first names making it impossible to distinguish female from male author.

5. In all the textbooks, few students (female or male) were depicted performing science activities. This discrepancy needs to be addressed in further editions of the texts to promote a relevancy of the reading material to the students.

6. In the three texts primarily examined, there were only 27 pictures of minority races/ethnic groups. The remaining pictures were all of Caucasians.

7. The presence of sexist language existed in all the texts and curricular materials. There were no examples where women were labeled incompetent in science. However, there were subtle indicators of the lack of importance women, in general, have in our society.

This analysis points to some drastic changes that need to be made in the current science textbooks such as incorporating women into meaningful pictures, illustrations, and career profiles as well as removing the generic use of "man" from the texts. In addition, the use of female diagrams in illustrations of anatomical systems other than the reproductive system should be instigated. Finally, there needs to be a greater emphasis on the use of many different ethnic groups in the photographs and illustrations.

VIII. CONCLUSION

This case study found the high school studied to have a very progressive attitude regarding educational opportunities for females. In addition, the population of residents include high-achieving professional parents who are presently applying a great deal of emphasis on science and math careers for their daughters.

The biology course taught at this school deals heavily with social issues but does not emphasize careers, women in science, and other feminist issues. The textbook is not used a great deal in the course. An analysis of the textbooks used by the science department revealed inadequate coverage of careers, few pictures depicting women scientists, miniscule numbers of pictures showing female and male science students involved in activities, and the use of sexist language.

The attributes of the biology instructor that may encourage girls into science include: her non-discriminating attitude towards girls; lack of sex-stereotyped comments; positive disposition; her willingness to talk one-on-one with the students; her energy and enthusiasm in the classroom; the relevancy she places on the material discussed in class; and her awareness of the situation of girls entering science careers.

Case Study D

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I. THE COMMUNITY

The case study community, with a population in excess of 50,000, is the county seat and the only city in the county with more than 10,000 people.

According to the community's Economic Development Corporation, the 1980 census showed the county's population to be predominantly white, with only 7% blacks and 12% other races. Of the 81% white population, 37% are of Spanish origin. Hispanics compose 30% of the county population.

Seventy-five percent of the county's population lives in the city.

Fifty-one percent of the total population is female; 62% of the females 15 years and older are married.

Twenty-two percent of the population is single; 25% are male and 19% are female.

Following the 1980 census the area was declared a Standard Metropolitan Statistical Area. The community's Economic Development Corporation describes the city thus:

> By all economic indicators, [the city] has a vibrant, dynamic economy growing at a pace comparable to most major metropolitan areas in ... the state. [Its] economic strength stems from many factors: a central location, the availability of a productive labor force, an efficient transportation system, and a variety of comparatively inexpensive resources.
>
> [The city's] immediate market area consists of a population of over 150,000 residing in4 [the] county and six surrounding counties. The economics of these seven counties are linked by labor, transportation, retail sales, agriculture, oil and gas, and various manufacturing industries. Total effective buying income for this market is well over $1 billion with approximately 35% of the households earning an effective buying income of $25,000 and more. Total retail sales for the seven counties approached $865 million in 1981.

The Economic Development Corporation also reports that the population of the county has a median age of 28.1 years. Ages 17 and under make up 32% of the county's population while 41% of it is the 18-44 group.

The part of the city served by the case study high school is less affluent than that of the other public high school. The students come from a wide range of housing types, varying from very modest apartment rentals to elaborate ranches. Their parents are mostly blue-collar workers, mainly in manufacturing, construction, services, and mining (oil and gas production). Many of the parents commute to jobs at several petrochemical plants in the area, while a large number of others are involved in farming and ranching, either as owners or employees. Almost none of the city's professional people live in the school's feeder area. The school is located in the southern part of the city while most new and expensive growth is extending to the north.

It is not known how many two-income families live in the area, but most of the people have limited educations and most are nonprofessionals. Thus, even those families with two wage earners likely fall in the average-to-below-average economic levels in the city. The 1980 per-household income in the county has been roughly estimated to have been $25,000 and more; but 22% (5,412 units) have an effective buying income (EBI) of less than $10,000.

If one religion is prevalent in the community, it is Catholicism. There are also highly visible fundamentalist groups. The area as a whole has many churches and the impact of religion is very apparent. There is even a large Catholic convent in the southern part of the city.

There are two large public high schools and a co-educational Catholic high school. The case study school is the newer of the two public high schools and is located, quite literally, on the "other side of the tracks." The school district comprises 18 elementary (K-5), 3 intermediate (6-8), and 2 high schools (9-12). There are also several highly acclaimed parochial schools, especially ones that provide instruction at the K-3 levels. The Catholic schools (K-12) enjoy an especially favorable reputation in the area.

The city also boasts a public junior college, which has been in continuous operation for more than 50 years and enables quality higher education at relatively low cost. Located on the same campus is also a branch of a neighboring state-supported university which provides upper division and master's degree programs in Education, Business Administration, and Social and Behavioral Sciences.

There is no evidence of any direct effect on students in the two public high schools by the presence of either the parochial schools or the schools of higher education.

The seven members of the Board of Trustees of the public school system are elected for overlapping 2-year terms and each is elected "at-large," though there are activities among some sectors of the population to press for single-member districts. The present Board consists of six men and one woman, one Mexican-American and six non-hispanic whites.

One board member, in an informal interview, stated that the Board is very careful to provide equal opportunity in the recruitment and hiring of faculty and support personnel in terms of gender. The member also explained that the school district is under a 1978 federal court order to employ more Mexican-American teachers to accurately reflect the ethnic make-up of the population of the district and that every possible effort is being made to comply. Naturally, such a requirement could mitigate against hiring a black or non-hispanic-white woman if an equally qualified Mexican-American man were available for the same position.

It should also be noted that the school district has a strong local tax base with property valued at fair market prices and a tax rate of $0.71 per $100 valuation. The total value of taxable property for 1982-83, after all exemptions were subtracted, was in excess of $1.8 billion. The single greatest item in the district's budget, as one would expect, is salaries. For the 1982-83 academic year, the district paid teachers from $3400 (for bachelor's degree) to $3900 (for the master's) above the minimum salary paid by the state. The area has a general atmosphere conducive to the development of all the arts. The local Arts Council, supported by public funds, lists 21 arts groups in the city catering to all ages of the population. Eleven of the groups are devoted to the performing arts, ranging from a children's chorus to the city's own symphony orchestra. There are 3 crafts organizations, 2 groups devoted to the visual arts, and 2 museums (one historical and one for visual arts). The city boasts an excellent zoo, housing only animals native to the state, and an outstanding public library. In addition there is a writer's guild and a historical preservation society. The Arts Council serves to coordinate activities and calendars of the various entities and apportions available public money to them through a system of grants. There is also a very popular Visiting Artist program in the public schools.

II. THE SCHOOL

The case study high school had a total enrollment of 1415 students during the Spring, 1983 semester. The school is located in the southern part of the city and consists of grades 9-12. A relatively large number of the students ride system-owned buses to and from rural areas; however, more students drive their own cars from both city and rural areas. The only regular in-city busing is done to transport students to the two special campuses, the Vocational Center and the Special Assignment Center.

An unusual feature of the school district is the Special Assignment Class (SAC), located in the building that formerly housed the black high school. SAC was set up as a place where students whose behavior is disruptive to school activities can be sent for a period of one to three days of intensive, individual "homework." If a student violates rules, has an unexcused absence, or is excessively tardy, he/she is not permitted to attend classes, is given assignments to complete for each class, and is sent to SAC for a number of days corresponding with the seriousness of her/his offense. Most students consider SAC a punishment to be avoided because the students are not permitted to talk to anyone and are permitted no privileges. Teachers and other school personnel praise the system for its effectiveness.

Another distinctive feature of the two high schools is that any student may be exempt from taking final examinations in courses in which he/she has at least a minimum semester average. She/he must also have a high citizenship grade in all of that semester's classes and have had no time spent in SAC. Recently, the final exam exemption privilege was revoked, but the outcry from students, parents, and faculty was so great that the policy was reinstated. A third feature of the schools that should be mentioned concerns the emphasis placed on science fairs. Each year there is a local fair for students of the two high schools, and winners then advance to the regional fair. Nearly every year at least one of the students advances to the International Science Fair. The case study teacher alternates on a yearly basis with a chemistry teacher at the other high school in chairing the local science fair. Students in the district's three intermediate schools (grades 6-8) have a separate science fair and some elementary schools have fairs that involve only their students. Many of these are science-math fairs.

The high school administration is headed by a principal, plus an assistant principal, a director of student activities, three counselors, and a part-time dean of women. Of this group, four of the seven are men, making 57% of the administration male. In addition there is a librarian and a part-time nurse, both of whom are women. If they are counted as administrators, the women become the majority of more than 55%.

The school faculty is organized by departments each chaired by a member of the department who teaches full time. More than half of the teachers in the school are women. About the only areas of the school program not dominated by women are athletics, agriculture, and shop. Many of the science and math teachers are women and there is a woman drafting teacher.

III. THE SCIENCE CLASSROOM

The biology classroom/lab used by the case study teacher is located on the second floor of a 2-story building on the west side of the main 4-story building. All the buildings except the main one have exterior halls and open stairways. The case study teacher has all her classes in this one room and no other teacher is assigned to it. She, thus, can organize it to fit her needs and has access to the room at times when she is not teaching classes.

Arranged throughout the room are seven stationary lab stations with water and sinks at stand-up height. Attached at either side of each lab station is a desk-height table that accommodates two students. All 28 places enable the students to face the side of the room where there is a large demonstration table backed by a long chalkboard. An attractive, well-maintained aquarium is at one end of the demonstration table. The room shares a common entry way from the exterior hall with a similar biology classroom. Storerooms are located on either side of the entry wall.

Male and female students are seated more-or-less randomly for their age group: most of the girls are together, most of the boys are together. For the most part, they also sit with members of their own ethnic groups. No one was seated at the table nearest the door.

Microscopes and the usual equipment and materials for a high school biology class are availble in the room. The usual array of audio-visual equipment, such as projectors and video monitors, are available upon request. The teacher is an accomplished photographer and frequently enhances class activities by showing color slides she has made. The students seemed very impressed by the photos from the Galapagos Islands.

The general appearance of the classroom indicated organization, activity, and a wide range of interests. One large bulletin board was devoted entirely to science career information, posters, and brochures. Other bulletin boards displayed pictures and information on biological topics. A simple poster stated three classroom rules. Cabinets were used to house equipment and supplemental books. A table at the front held boxes containing tests and homework that students could retrieve and journal articles they could check out. On the opposite side of the room a file cabinet was topped by reference books that the students use during the class. All the materials seemed to be organized and spaced about the room to enable a minimum of congestion and confusion.

The general atmosphere of the observed classes was one of business-like, efficient activity. The teacher appeared organized but flexible, efficient but relaxed. The students seemed to know what was expected of them, and proceeded to carry out their tasks with a minimum of commotion and no evidence of confusion.

An examination of tests and handouts prepared by the case study teacher showed no bias toward or against females. In addition, the teacher has said that she is unaware of any evidence of sexism in the textook or any other materials she uses in her class.

IV. THE SCIENCE TEACHER

Special attributes of the case study teacher which might encourage girls to go into science are her appearance, poise, approach to her work, and apparent attitude toward other people. She doesn't seem to get upset easily and the students remark that she keeps firm control in the classrom. She is friendly, exudes an interested, helpful self-confidence, and obviously enjoys her career. These traits make her an excellent role model for boys as well as girls.

Girls may or may not be influenced to pursue science careers by knowing that their biology teacher is single, owns her own home, and is very much in control of her life. She travels extensively and enjoys most nature study activities including birding, shelling, and marine biology expeditions. Most of her students are interested in the latter two and seem to really get involved in class discussions of these.

The case study teacher uses every vacation for travel that enhances her learning and teaching background. She has taken nature study tours to the Galapagos Islands and to the Pacific Northwest.

The case study teacher sponsors the Student Council and has sponsored the junior and senior science clubs in the past. She alternates each year with a chemistry teacher from the other local high school as director of the local Science Fair. These two women have quite different personalities, but they work well together and have a lot of qualities in common. The case study teacher demonstrates calm enthusiasm, is organized, and quietly in control of the situation. She is a member of the State Science Teachers Association and was selected in 1981 as the a recipient of the National Association of Biology Teachers' Outstanding Biology Teacher Award.

The science teacher reports that she is quite aware of the sexism that is apparent in national advertising, but that there seems to be less in regional and local advertisements. She says that sexism is less noticeable in movies, television programs, and articles in newspapers and news magazines. The career brochures, textbooks, and other published classroom materials that she encounters do not seem sexist. She did comment, however, that the textbook she uses has attempted to include some mention of women scientists and the few entries appear added on and irrelevant.

No difference can be detected in the manner in which this teacher deals with girl and boy students. She says that she feels no differences in her expectations for the two genders, and it has been observed repeatedly that she does not differentiate between them in her dealings with them.

VII. TEXTBOOK ASSESSMENT

The textbook used in the case study class was analyzed for sexist language and bias in presentation of information. Unfortunately, the narrative of the book has no mention of any contributions made by women to biology and the few places where women are mentioned in the illustrations can be regarded as tokenism. The authors and/or editors seem to have carefuly avoided using instances where they would refer to an unidentified individual with the neutral "he." The book, however, does not seem at all male chauvinistic or anti-female, because nearly all of its contents have to do with biological features and phenomena. The researchers who are cited are all males, but then, they are the ones who have made the notable contributions to the field. To include female researchers just to include females would be misleading, artificial, and contrived.

Case Study E

Frances S. Vandervoort
Biology Teacher
Kenwood Academy, Chicago

I. THE COMMUNITY

This case study school has had a long and distinguished career as an educational institution in the city's public school system. Built in the first decade of this century in a prestigious district of a large Midwestern metropolis, this high school was THE public institution to which to send children. The only real competition for the high school was a university laboratory school, but many university faculty sought the more traditional approach to schooling offered by a good public high school. The school prides itself in having been accredited by the North Central Association for more than 75 years.

In the early 1950's, changes occurring in many urban areas began to affect the high school. Urban blight, racial instability, and dropping property values brought about changes that were reflected in the school. Within a decade, the district changed from middle class, white to almost totally black. The suburb immediately to the north, began to experience the same changes. Within a decade, the school's prestige dropped from among the highest in the country to among the lowest. Gangs vied for the control of the student population. Ebbing teacher morale reached an all time low in the early 1970's. Only students brave or tough enough to withstand the threats of gangs walked the half-empty halls. Many of these recognized that despite the hazards of the local environment, enough good teachers remained in the school to make it worthwhile attending classes.

The early and mid-1970's saw a vast infusion of funds into the school. A total renovation of classrooms, new laboratory space and equipment, a library, and many other features resulted in a school that was a model for inner-city high schools everywhere. A change in its name was a major event in the renaissance. The new name, "Career Academy", reflected the Board of Education's commitment to career education and its desire to shed the tarnished image of the past. Today, the academy is actually four schools in one. It is a comprehensive high school, drawing students from the eight feeder schools; it is also a "transitional school" addressing the needs of students with special problems of motivation, attendance, and skill development. The school contains a college center that offers evening classes in which students can obtain college credit in a variety of subjects. An urban skills center offers classes in woodworking, typing, calligraphy, and a wide variety of other subjects of general interest. Finally, the high quality of its magnet curriculum attracts students from all over the city. The cooperating teacher for this study teaches biology in the magnet program.

II. THE SCHOOL

The assistant school principal has been working at the school since 1976. She provided information about the demographics of the school.

Overall, the economic base of families of students is fairly low, although there has been a recent influx of wealthier families. In particular, new townhouses and highrise housing have made living in the district more desirable than it has been for the last two decades. Some new residents have elected to send their youngsters here. The present enrollment of the school is about 2700, and all students are black. The hope that a high-quality academic program would attract white students has not yet been realized. Also, one of the city's finest public high schools is only about 1-1/2 miles north. Since this newer school was built in 1968, it has served as a powerful attractant for students of all races.

The school community provides limited opportunity for shopping. Most residents travel several blocks to the south for groceries, or north into the city for other purchases. The major east-west thoroughfare near the school, is largely devoid of commercial enterprise — most buildings were torn down in the mid-1970's during an urban renewal project that is still far from completion.

Cultural opportunities in the community consist of a Museum of Science and Industry, a Museum of Afro-American culture, and a major university which provides a variety of educational opportunities at the case study school. Field trips to these and other institutions are frequent.

Predominant religions of students are Protestant (Baptist, AME Methodist, etc.). Some students are Muslims, although the Muslim population has declined in recent years.

Most parents of students in the magnet program have at least high school degrees. In many instances, both parents are working. There is active parent participation in the school. A parent-teacher-student council meets several times a year. Parents volunteer their services in the attendance office, as hall guards, and in other school activities.

Attendance in the entire school is presently very good. The school now has a drop-out rate of only 0.004 percent. The school has a program called "Being There" that is highly successful in promoting good attendance. In addition, there arehas several innovative teaching programs, including a team-teaching approach to career development. There are eleven work-study programs throughout the city. Work study programs in the sciences include health care and work in a veterinary clinic. Because the renewed emphasis on academic excellence did not really begin until 1975, it is too early to see a general picture of success in scientific or other professions. Graduates of this school have been awarded scholarships to outstanding colleges and universities, and a number of them are known to be studying scientific fields.

True measure of success will come when these students are established in scientific careers.

The school has an adequate supply of audio-visual equipment, and has a laboratory containing 15 micro-computers. The school anticipates obtaining more micro-computers as well as training programs to go with them. The school has been "adopted" by the Digital Corporation, which will help in training programs for students and teachers.

As in all high schools, the guidance department advises students in the selection of courses within the school and in the selection of colleges and universities. It provides counseling in career awareness, and offers help for the general problems of high school students. An interview with the chairperson of the guidance department, provided the following information.

Students enrolled in the magnet program are taught in classes separate from those of students enrolled in regular high school classes, probably because it simplifies bookkeeping. Most, but not all, of the students in the magnet program are "honors" students.

No special support is given to girls who wish to go into the sciences. The department's goal is giving equal support to all students. Girls who excel in class do not seem to be looked down upon by boys, at least as far as the chairperson of the evidence deparmtent is aware.

An interview with a guidance counselor who works with the Office of Special Programs of a local univeristy revealed other aspects of the school's complex program. For example, her comments about the involvement of girls in the Office of Special Programs was revealing in that it showed a problem frequently expressed by black educators, that black girls are more successful academically than boys. For example, male and female students enroll in the magnet program as freshmen in approximately equal numbers. By the end of the sophomore year, girls are more likely to be retained than are boys. For example, in honors chemistry classes, girls tend to outnumber boys by as much as 22 to 4, and in the advanced placement class there were 14 girls and 2 boys. The counselor feels a special concern for this problem, but recognizes that it is due largely to the pressures to succeed socially and athletically that confront teenage boys in the inner-city. Girls seem better able than boys to withstand these pressures.

III. THE SCIENCE CLASSROOM

The atmosphere in the science classroom was quiet, congenial, and businesslike. Bulletin boards contained a panorama depicting the evolution of humans, as well as representatives of the animal and plant kingdoms. Various plastic and plaster models were on shelves and in cabinets in the room.

IV. THE CASE STUDY TEACHER

The case study teacher is an instructor whose philosophy is "shoot the moon." It is an attitude that she wishes she had had as a college student, and that she believes is the only philosophy to follow for real success. She is in her late thirties, black, divorced, with one child. She has taught for 14 years in parochial and public schools and is a graduate of A Big 10 University. She also has a master's degree in educational administration. She presently is teaching freshman biology in the magnet program. She has taught advanced placement biology in past years, has served as science fair coordinator, and has been deeply involved with the local university's Office of Special Programs, a program developed to provide support for inner-city high school students. She sponsors various extracurricular activities not directly associated with academic achievement, including the school's horseback riding club and ski club.

She moved to this metropolis from Mississippi as an infant and attended the city's public schools. Her parents, who were divorced, did little to encourage her into an academic career. Her first goal was to be a secretary, but teachers her high school, where she was one of the few blacks in attendance, told her that she could "do much better than that," but they didn't tell her what "better than that" was. Even though her biology teacher wasn't a particularly inspiring person (she made students spend a lot of time copying out of the book), the case study teacher found the book very interesting to read. Also, she struck up a friendship with the proprietor of a nearby funeral parlor, who let her observe his work. By the time she had graduated from high school she had decided to study pre-med in college.

Her first set-back came when she began looking for a college to attend. Her high school sponsored a "college day," a day of visitation by major and minor educational institutions that sent representatives to interview prospective students. She was excited by the program offered by the major, local university, and had her heart set on going there until she learned of the steep tuition. With a heavy heart, she enrolled at another local univeristy for $97.00 a semester. Only much later did she learn that she probably would have qualified for a scholarship to her preferred univeristy. Her high school, which was predominantly white, provided her with little counsel, and her parents were not sophisticated enough to advise her about future plans. Her mother always had the attitude that "educators know best," so that whatever the teacher or counselor said is what should be done.

She regrets her willingness to accept the advice — or non- advice, as it was in high school — of counselors and advisors. Her academic counselor in college saw her high grade point average, asked her what her plans were, and, finding the limited status of her finances, promptly discouraged her from applying to medical school. He told her that since she would probably want to get married and have children, her chances of finishing were very slim. She left the counseling session pleased that the counselor had taken the time to talk with her before she had gotten too far into pre-med.

She took enough courses to qualify for medical technology. She worked in this field only a short time before isolation and minimal opportunities to work with patients drove her to seek a more rewarding field. She took enough education courses to qualify for a teaching certificate. Thus began her teaching career. To this day she regrets taking the path of least resistance. She now knows that she would have been eligible for almost any scholarship offered. By the time she graduated, colleges were giving scholarships to students "just for being black." There is no doubt that her high school and college experiences have played a strong role in her attitude toward her own students.

The following excerpt from a taped interview with the instructor gives a clear picture of her attitude toward motivating students.

> As long as I feel the kid is academically inclined, I will push, shove, tug, anything. Now I have a young man who wants to go into computer engineering. I have a cousin doing that for IBM, and I have introduced him to this kid. My cousin took him out to lunch, and is now going to take him out to his job. I feel that I had a lot to do with the fact that some students are at Harvard rather than at the State University. One student, a girl, was willing to settle for the State University, but I said, 'Stephanie, do you know how bright you are? I give very few A's, but if I could have given a grade higher than A you would have gotten it. You won $1000 in the City Science Fair, doesn't that tell you something?' Well, she applied to Harvard, they grabbed her and gave her a scholarship with room and board. My attitude is 'Hey, if you shoot for Harvard and miss, so what? If you don't shoot, one day you'll be thirty years old and say maybe I could have gone.'

The case study teacher is considered an outstanding teacher by her superiors and colleagues. In 1979 she was a recipient of the coveted Blum-Kovler Prize, an award granted to teachers who perform service above and beyond that required by their contractual obligations. Visitors to the school have commented upon her outstanding classroom environment to school administrators.

She admits to placing high demands on her students. "In the first ten weeks of the semester," she says, "we have 'declared war.' After that, most students see what the goals are." Parents, in general, are very supportive of her approach to teaching, often because they have enrolled their youngsters in the magnet program because of the opportunities it provides. She is confident in her ability to handle most crises that arise with parents, and prefers that the administration send parents directly to her with their complaints.

The textbook used in her classes is the 1981 edition of Modern Biology (Holt, Rinehart, & Winston). (Note: This is the most commonly used text in the local public school system.) She prefers the BSCS Blue Version, Molecules to Man, and has ordered it for the coming year. She feels that its biochemical approach is appropriate for her students. She considers a textbook a primary frame of reference for biology, but requires students to use the library to delve deeper into scientific topics.

Professional organizations do not play a major role in her teaching, but she feels she benefits from organizational journals, such as the American Biology Teacher. She scans journals to find ideas that she can use in the classroom. Although she has attended a few conventions, she does not feel that she can learn a great deal from them. Conventions with presentations related to a perceived need are the only kinds she enjoys, but in most cases she believes that "she could have taught the seminars." She believes that the exhibits are useful, and has ordered some of the materials she has seen for the classroom.

In addition to motivating students to strive for academic and professional excellence, she seeks to change their attitudes toward biology. Words such as "nasty," "ugly," and other such terms are unacceptable. She wants to give students an appreciation of things that are not familiar to them. They must become thinkers and listeners. Career awareness is another goal; Joyce has invited speakers from a variety of scientific disciplines to address her classes. She has taken students on field trips to museums, to a national laboratory, and to nature preserves and zoos. Students prepare "career profiles," — oral and written reports on various scientific professions.

The case study teacher does not hesitate to discuss controversial issues, attempting in each case to give balanced presentations. The creation-evolution controversy may cause a problem in an inner-city school, because many students are from fundamentalist homes. Her approach is that "nothing is etched in stone," and that "scientific material is theoretical, based on scientific evidence." Environmental problems are usually discussed in reports made by students. She is concerned that ecology units are usually placed at the end of textbooks, with the result that little time is available for this important subject at the end of the year.

She relies heavily on film strips for teaching new materials. The unavailability of films from the central film office when they are wanted limits her use of this form of media. She requires her students to use the school library and public libraries for group and independent projects. Her experience, attitudes, and goals give her tremendous strength in motivating students to achieve. She is an exemplary teacher.

Observing the instructor and talking with her, her colleagues, and her students, leaves one with the strong sense that there are no simple explanations for her success as a teacher. A major factor in her desire to motivate young people developed because she, herself, was frustrated in her search for loftier goals. She also is able to recognize the special needs of black inner-city students and address them in a sometimes humorous, always supportive way. She has a keen understanding of biological principles and a love for the field that is an important key to success in any subject. She is given recognition not because she seeks it, but because it is so well deserved.

V. THE CASE STUDY STUDENTS

All four students concurred that the best part of this teacher's classes were the discussions. The discussions, according to the students, are frequent and productive.

> [She] always has discussions. We always ask questions, and we learn the most from discussions.

Another student commented:

> I never liked biology in the first place. My teacher helped me take an interest in the class.

The students are comfortable asking questions, but are aware that if they ask a question for which she thinks they should know the answer, she will give them a "look." Students feel free to ask her questions outside of class. The major objection the students have to the class is the amount of homework, "especially at the beginning of the year." The material learned and the opportunity for discussions make up for the hard work. They respect their teacher for her organization and her ability to hold productive discussions.

The students do not feel that she spends an inordinate amount of time on careers, but they have enjoyed guest speakers in the classroom and the preparation of career profiles. They do not seem to feel that their teacher spends much time talking about environmental issues, but they have enjoyed discussions about genetic engineering and test-tube babies. The students enjoy the filmstrips shown in class.

Because the students are enrolled in the magnet program, they are encouraged to take as much mathematics and science as possible. They sense strong support from their parents in their studies.

The impressions students have of scientists are generally negative, although they recognize that scientists are probably doing what they want to do. They envisage scientists as men in long white coats looking through microscopes. They think more men than women are scientists, and two students would place more faith in the work of a male scientist than a female scientist. Two other students said they would trust the work of men and women equally, but then qualified that statement:

> I would trust [the work of men and women] the same if they have enough background to know what they are doing. I think women usually don't have enough time to work to know as much as men.

The four female students interviewed agree that women have to work much harder than men to succeed.

They never want to marry scientists, because scientists would never have time to be home with their families. They agree, however, that it would be more difficult for female scientists to devote adequate time to their families than males.

> If I married a scientist he'd never have time to be home with his family. I think [men scientists] would have more time [to be spouses and parents] than [women scientists]. It depends on the woman. If she can do it, fine; but most women can't.

VI. TEACHER/STUDENT INTERACTIONS: CLASSROOM OBSERVATIONS

Students in the case study teacher's magnet biology class are seated according to score; students seated toward the front of the room have higher point scores than students seated toward the back. Student scores are totalled every five weeks or so. More girls than boys seem to sit toward the front, but questions come equally from students throughout the room. The teacher addressed questions equally to boys and girls.

In the class observed (April 13, 1983) students spent a few minutes reading one section of the text in unison, and then began a short reading assignment. There were questions about the preparation of a bibliography. The instructor advised students to avoid the journal Science because of its high technical level.

Students worked for a while with flash cards depicting various levels of classification. Students were given numbers that determined team membership. When the teacher gave one female student the number 5, the student repeated the number, saying "fahv." At that time the teacher gently repeated, "fahv?" The class laughed, as the teacher said "How about five?" (pronounced with a long "i"). The girl then pronounced it correctly. The case study teacher would have had no hesitation making the same comment to a boy. Later, two boys sitting in the back row (because of lower class rank) were asked to pick up the flash cards. Teams of two students are the same or opposite sex, and work together quietly and productively.

The teacher answered questions from boys and girls in a non-partial way. One boy, complaining that the librarian "threw him out" as he was attempting to complete a research project, was admonished to allow the librarian to "do his work."

Because I was in attendance, the students were given the "treat" of watching the room's boa constrictor being fed. This impressive reptile resides in a large glass case on one side of the room. Next to it was a cage containing two or three white rats. A sound of approval arose from the boys, who began to cluster around. The girls tried to suppress expressions of dismay and disgust as the snake quickly wrapped its coils about the hapless rodent. The boys' comments about "squashing" and "eyes popping out" were made largely for the benefit of the girls, most of whom avoided even looking at the spectacle. There were ten boys and ten girls present in the classroom, although a few students of each sex were absent.

VII. TEXTBOOK ASSESSMENT

Text: Otto, J.H., A. Towle, & M.E. Madnick. *Modern Biology*, New York:
Holt, Rinehart & Winston, 1981.

Number of Male to Female Authors Cited in Bibliographies at Ends of Representative Chapters

Unit	1	2	3	4	5	6
Male	10	10	10	9	11	13
Female	1	1	3	3	0	2
Unknown	0	0	1	1	1	2
Total	11	11	14	13	12	17

Males & Females Pictured (cited) in Research Section
Modern Biology Contains No Research Section

Male/Female & Black/White/Other Breakdown from Pictures in Representative Chapters

	Chapter 1	Chapter 11	Chapter 16	Chapter 40	Chapter 41	Chapter 52
Male	1	1	1	1		2
Female					1*	2
Black						1
White	1	1		1	1	3
Other			1			

Researchers Pictures in Text: Only a Meager Number

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*"Typical" woman's job: dietician

Although the number of researchers, scientists, and people in general are most often male, the text (written text) does not favor one gender over the other. The narrative in general, and even captions for photographs, avoid the use of gender.

Case Study F

Jane Abbott
Biology Teacher
Waterville High School

I. THE COMMUNITY

The case study community is in a northeastern state and is about 20 miles north of the state capital. The City Manager states that socio-economic levels vary according to the part of the city. Some parts of the city are listed as having 99% poverty level families. Yet, overall, he states that a higher than average number of families own their own homes. There are large numbers at both ends of the spectrum.

The town has three hospitals, two colleges, a police academy and a neighboring college as well as a large paper company, a fiber company, and a clothing manufacturer. These lead to a large number of medical personnel, professors, and industrial executives. The industries and their support personnel also contribute to a blue collar group as well as many non-skilled personnel.

The population has remained at about 18,000 for some time. Since there are many rural areas around the town, the shopping population is considerably larger, and the community is considered a medical center for the area. A major woolen industry recently failed and another industry was affected by a prolonged strike but, in general, it is a stable community.

Many families have migrated from Canada with the result that quite a few residents, especially older people, speak only French. The majority, however, speak English. The largest population group would be French Canadian. There is a small Jewish and a small Lebanese population with the balance a typical European mix. There are many more Catholics than any other denomination. There are, however, all religious groups represented with a small, but active, Jewish congregation, many large Protestant churches and relatively few fundamentalist groups.

The cost of living is quite high. Real estate is valued at 100% with many residents feeling it is much higher than 100%. The mill rate is 21.30 per $1000. Electricity, fuel oil and gas are higher than the national average. There is a lack of discount stores. The ecology of the area is interesting. The area has been glaciated and is between the Mid Latitude Deciduous Forest and the Taiga biomes. The state has a bottle (returnable) law and one of the best oil handling regulations in the country. Environmental problems include acid rain, toxic dumping, and air pollution.

For the size of the community there is a wealth of cultural opportunities. The adult education department of the high school offers a wide variety of cultural courses as well as career-oriented courses and the opportunity for anyone to obtain a high school diploma free of charge. There is a central vocational institute which provides an opportunity for career training on a part-time or full-time basis. There is a privately run theater group with a professional staff which has programs at the Opera House. A nearby college has an art museum with continually changing exhibits; many special programs and visiting lecturers; a large ice rink for hockey games and private skating; an athletic complex with unlimited swimming, etc., available to anyone for a minimal fee; jogging and cross country ski trails; an early morning, free physical fitness program for senior citizens; and many concerts and musicals. A small local college, although a business college, offers many similar programs. There are two extensive nature trails owned by the city - one along a neighboring stream and the other along a large river. A free municipal swimming pool with instructions for children and a municipal golf course are available in the summer. The Country Club has winter and summer activities and a beautiful, 18 hole golf course. Nearby are a summer theater, a Shakespearean theater, mountains for climbing and/or skiing, and the ocean providing a multitude of recreational activities. Fishing, sailing, scuba diving, and camping are popular. A national park and many state parks are available. The town is in the heart of the lake country with many residents owning or renting summer camps at nearby lakes. There is an active "Y" as well as Boys' Club-Girls' Club and many programs such as Little League for boys. Girl Scouts and Boy Scouts are active also.

There are many professions represented on the school board, which currently includes mill workers, lawyers, doctors, blue collar workers, and a housewife. The town's college professors usually are not elected. Many of the professional people are sports oriented. The community is very interested in athletics and this fact leads to an uproar whenever a sports program is threatened with a financial cut. Football and ice hockey are top priorities.

There are two elementary schools, one junior high school, and one senior high school in the public school system. There is one small fundamentalist school and one Catholic elementary school. Until very recently there was a Catholic high school and at least three Catholic elementary schools with high enrollments. It has been suggested that a reduced enrollment and the difficulty in obtaining nuns and other teachers led to their gradual demise.

As a science teacher, one might have noticed that students from the Catholic schools were less well prepared in the sciences but fine in the arts. At one time the public high school was contacted to assist the Catholic schools in developing a science program, but it was not followed through because of a lack of funds.

Some students take typing and other courses at the local business college when they cannot fit a course into their high school schedule. The other local college, a liberal arts institution, has long been a source of expert help for students doing research projects, a center for cultural activities such as visiting science lecturers or symposia (20 students from biology just attended a 2-day bio-medical symposium as guests of the college), and a location for field trips. The college's arboretum and bird sanctuary with available guide books to the facility is available, and a kettle-hole bog is nearby. Accelerated students are able to take college courses at the college for minimal fees. Professors from the state university (65 miles away) have been willing to come to the school to spend a day with students. Another college (30 miles away) offers environmental summer programs and a basic computer course in the summer which includes elementary students (the tuition fee includes the cost of the computer which the student takes home).

II. THE SCHOOL

The high school was built in 1962 in the middle of a downtown residential area. The student population has recently dropped to 923 from an enrollment of about 1200. The town encompasses 18 square miles. Few students are bussed because of the relatively small size of the city. Since the junior high school was built on the outskirts of town, many more students are bussed there. Neighboring towns, which do not have a high school, send their students to a school of their choice. Many choose the case study high school in spite of the fact it is not the nearest one. Since Waterville is an area vocational center, some students are transported from neighboring schools for part of each day to attend the vocational center. The junior high has grades 7 and 8, the high school 9-12. All schools are accredited.

Although the community spends less per student than many other schools in the state, I think it is accurate to state that the community supports the schools. The high school has a model library for the state, originally funded by the state but currently supported by the local taxpayers. The media center occupies one wing of the school and includes an extensive audio-visual department with TV and video tape equipment. A loan system allows students to borrow all types of records, including jazz; large paintings; tape recorders; and all types of photographic equipment, including 35 mm and movie cameras.

There is a large room for quiet study in carrels and a large circulation room where talking is permitted. The large hall has a variety of exhibits and houses special programs, including visiting speakers and movies which students can attend during free periods. Equipment throughout the school is quite good. The media center is exceptionally well equipped. However, the capital improvement fund has been frozen in recent years with a resultant reduction in quality and quantity of equipment and an absolute freeze on the introduction of new equipment. The math department, however, has been able to obtain funding for the initiation of a computer proficiency program for all students and for interested teachers.

Daily attendance is about 94% with a truancy rate of 1%. The assistant principal says that the average class size is 23, but most academic classes are considerably larger. The lower average is due to small classes in special education and other classes with small enrollments such as home economics, shorthand classes, and more advanced levels of foreign language. There are not many rules for student conduct. Until this year an open school policy permitted students to leave the building if they did not have a class. This year a closed campus policy is enforced. Each student is allowed 10 unexcused absences a year per class following which he/she receives an F. A study hall cut results in a cut in every class. However, there appear to be many administrative waivers and exceptions. Students are now starting to take advantage of the 10 cuts, and the record-keeping is time-consuming for teachers.

Classes are 40 minutes long. Lab science classes meet 7 periods per week. Teachers have one prep period a day and a 20-minute lunch period. About 1/3 of the staff is involved in extracurricular activities but all teachers are assigned to committees and duties. Field trips are scheduled as requested by teachers with some limit on distance. The assistant principal states that student support for the school is less than average. Most teachers feel that motivation and achievement are considerably less than in the past. Class scheduling as it affects science classes is adequate. There is a 4.0 point grading scale (A, B,C, D, F) with 60% being a passing grade. Twenty percent of the students are reported to be employed.

There is one principal, one vocational director, a guidance director, an athletic director, a head librarian plus six staff, one assistant principal, and department chairpersons for each department. The business, language, guidance, and science chairpersons are female. The science personnel include 9 people, two of whom teach just one course. Al* teaches 5 classes of academic general science. Ann* teaches health, general science, and a combination physiology and environmental science (one semester each). Sue*, a home economics teacher who does not have a full load in home ec, teaches one health class. Mary* teaches the slow learners both general science and health biology. Bill* teaches academic biology and health biology. Joe* teaches all chemistry classes. Fred* teaches 3 physics classes and one general science class. Jim*, the assistant principal, teaches advanced placement (AP) physics. (It is not really an AP class but an honors class which has all of the top physics students.) The case study teacher teaches academic biology and is the science department chairperson. The members of the science department have had excellent rapport. One means of accomplishing this has been to have departmental meetings in the homes of members with one member demonstrating interesting items of equipment such as the laser for physics. In total, 337 girls and 333 boys take science. The breakdown in the lab sciences, which are all college prep, is as follows: biology, 107 girls, 69 boys; chemistry, 46 girls, 51 boys; Harvard Project Physics (for non-math oriented students), 8 boys, 5 girls; PSSC Physics, 18 girls, 15 boys; AP (honors) physics, 9 girls, 11 boys. This year, probably for the first time, a girl received the award for being the top physics student. It is possible that if the AP physics teacher had realized that a girl could succeed in

*Names have been changed for anonymity.

science, she would have beenconsidered more seriously for the Bausch & Lomb Science Award.

A series of interviews with administrative and counseling personnel revealed distressing attitudes about the education of women, particularly in the sciences. The following are excerpts from these interviews.

> The assistant principal, former physics teacher, was expected to be an outstanding administrator by many of the faculty when he assumed that position two years ago. Things started out very well but he apparently became fed up and things have gone from bad to worse. He instituted the attendance policy this year which he did not follow through on and which has been the most unpopular innovation ever introduced. Since he still teaches just the honors physics class, I asked him about the girls in that class. Except for the one student, who is the top physics student and a girl, he indicated that the better students are male. I definitely had the feeling that he thinks males are better, at least in physics, than females.
>
> The guidance department chairperson, a woman, appears to bristle at the suggestion that the question need be asked about sex bias in course or career counseling. Yet, on an interview with a student in biology this year I discovered a perplexing situation. Sue, a biology student, told me that [her counselor] had told her she was not capable of handling algebra and that she should take essential math. Sue, with an IQ of about 116, got mad and decided to "show" [him]. She received an A- in algebra. I suggested to Sue that perhaps [her counselor] had confused her with someone else but Sue is adament that this cannot be the explanation. Sue did not want me to pursue it with Ms. Beaulieu so I did not. Someone suggested that since the business department has been really hurting for students that perhaps she is trying to increase the number of students there.

In addition, the following questions concerning careers were asked one of the male guidance counselors.

Question: Do you find any subtle discrimination in the literature available on careers?

> I don't know if it is the culture or the parents. I would have to say there seems to be an inclination in the literature to say the female is given a somewhat lesser role. Certainly, [that is true] in the audio-visual aspect of career materials. But I know there has been a real change in this over the last 5 years, particularly in guidance materials.

In the same interview the male counselor reflects on the present situation concerning the career choices of women.

Question: Do you have any final comments?

> Well, being the father of two daughters, I want women to have every possible opportunity. I feel that in our culture, there still is a double standard. I think some parents think, 'Why finance my

> daughter going to college for six or seven years and then going off and getting married?' They should make the first priority to allow the girls to learn a skill.

Several times in the case studies, it has been observed that changes in the attitudes of male teachers, counselors, and administrators occurred when they found differential policies affecting opportunities opened to their own daughters.

III. THE SCIENCE CLASSROOM

The room was poorly designed with no opportunity for flexibility. Lab tables are rubber topped and bolted to the floor with each table (row) having six seats. Each student station has a double electrical outlet and a bunsen burner. Five rows allow for 30 students but there is also a row of movable desk-seats near the windows, allowing for a theoretical student class size of 35. However, the teacher uses the last row for heavy equipment and other supplies. There is a teacher's desk in the back of the room where students can use audio-tutorial units or work independently. The teacher's desk is in the front along with a long well-equipped laboratory table. There is one sink in the front of the room, one in the back, and a large sink in the storage room behind the teacher's desk. The teacher has another desk in the storage room which also has a full length window, refrigerator, and floor-to-ceiling shelves with working space and electric outlets.

Distilled and/or deionized water are available from the chemistry lab. Most chemicals for biology are stored in a separate room. In addition, there is a two-room area for storage of materials for chemistry classes. There is a lighted five deck germinating system as well as a germinating bed and a large soil bin. A built-in steam sterilizer, obtained from government surplus, is a convenience.

At the time when the teacher was coordinator of a drug prevention program for both the state and high school, a group of students painted dramatic pictures of bison, fruitflies, lobsters, etc. on the walls of the room. The long shelf next to the window contains a great variety of plants, many of which are used for lab work. A large, brightly colored, student-made wooden DNA model is prominently displayed. A marine mobile (student made), cat and rabbit skeletons (student made), and a variety of stuffed animal specimens are placed around the room. A bog and a woodland terrarium occupy a shelf away from the bright sun.

Every room in the school is equipped with a pull-down screen, overhead projector, venetian blinds, two walls of chalkboards and bulletin boards, and the American flag. The type of displays varies with the topic under discussion. At the moment, there is a fossil display with marine fossils taken from a local gravel pit. Since the bulletin board is in the back of the room, few students look at it. As a result, the teacher uses masking tape to put relevant news items on the wall just inside the door and, on occasion, gives voluntary quizzes on what is contained in the items. There is a long window shelf which contains many plants, demonstrations, and displays. It overlooks the a stream which provides a delightful view.

Probably the most interesting piece of equipment is the refrigerated marine aquarium in the back of the room. The teacher persuaded a former superintendent to purchase it by pointing out that there would no longer be the need to purchase tropical marine specimens each year. She keeps the aquarium stocked throughout the year by scuba diving for native specimens. At the moment there are three scallops, sea cucumbers, sea urchins, star fish, sea anemones, comb jellies, hermit crabs, mussels, and snails. The students enjoy watching their antics, especially those of the hermit crabs, the reproduction of all the animals, and the feeding of barnacles. Other special equipment includes: a large scaler, given to the teacher at an NSF summer institute; a photographic enlarger which belongs to the teacher; Millipore sterilizer and equipment for bacteriological studies; a high volume air sampler given to the teacher in return for evaluating it; an antique carbon arc projector; a large sterilizing oven; a temperature and humidity controlled bird incubator; a bacteriology oven; a large, precise, temperature controlled oven; a temperature-controlled water bath; a TV; a large built-in fresh water aquarium; two large, biological chart sets; and a skeleton.

IV. THE SCIENCE TEACHER

An attitude which expresses the opinion that "nothing ventured, nothing gained" truly describes this biology teacher and her views about living and teaching. All students know she is a commercial balloonist as the local paper headlined a balloon accident she had last summer. Students often tell her that other teachers in the school have told them of the many "great" things she has done. Interestingly enough, these teachers are usually male, almost as if they think it is very unusual for a woman to have done the things she has. Students have learned from other teachers that she learned to fly airplanes before World War II; was asked to ferry airplanes across the Atlantic during the war; built a camp with her husband including wiring it; reroofed her house; and repairs machines for other teachers. Teachers visit her classes from other school systems to observe how she teaches. She is department chairperson.

She has been on the Girl Scout Council, had a Girl Scout Mariner Troop, and organized and chaired the Girl Scout Day Camp which some of their mothers and sisters attended. She was the first woman President of the State Biology Teachers Association and also of the State Science Supervisors Association. When she had the Fund for Education financing ($24,000 from the Ford Foundation) for science enrichment, she included as many girls as boys. Some of the girls made an excellent illustrated demonstration of the transect down a nearby mountain; later they adapted the techniques to use on a famous ski mountain in the State. She has had many girls attend the summer research program at a well-known laboratory and also Project Earthwatch. She has taken many girls to hearings in the state capital on environmental issues and helped them to become involved in making their viewpoints known on such issues. One girl was asked to publish the results of her research in biology. Girls have participated in before and after-school special activities in biology, including an after-school program with a woman chiropractor. Both boys and girls participate in and enjoy the co-curricular activities.

In the following interviews, a past student of this science teacher reflects on how her high school biology course has been useful in her career and on the individuals who encouraged her to pursue a science career.

Question: Do you think that any of the things you learned in biology have been useful to you?

> I think the high school biology courses and my training in college certainly prepared me for my career in research. [In] the high school biology class, I remember going on many field trips. [In addition] the questioning and searching for information was certainly helpful to what I am doing today.

Question: Did you ever get a chance to ask your teacher questions about biology outside of class?

> Yes, I think we had a very open relationship. I know I was enthusiastic about biology, and because of [her] enthusiasm and my enthusiasm, I think there was a communication there.

Question: Is there anyone, teacher, parent, family, who encouraged you in your science studies?

> Well, certainly my high school biology teacher did, and my grandfather was a big influence in my desire to stay in the biological field. He was a deer raiser. As far as the behavior of the deer was concerned, he was always aware of how, behaviorally, the deer were going amongst the herd. In the fall we would do the annual slaughtering of the deer, and he would point out the various organs. So he sort of instructed me and helped me pursue my interests.

An English professor at the local college, who teaches a course in Women's Studies, has used the biology teacher as a role model in a recent presentation at the college. The initial impetus for the choice was the fact that the biology teacher is a commercial balloonist and was a pilot during World War II. In the program the students who interviewed her also brought out the fact that she was a department chairperson and was a leader active in local, state, and national science-related activities.

V. THE CASE STUDY STUDENTS

Interviews with three students of the case study teacher indicate that the students appreciate the diversity of learning materials and activities in their biology course. Students listed the marine biology specimens, the genetics units, laboratory work, dissections, and field trips to a bog among their favorite activities. One student described the activities she really enjoyed in the following way.

> We have had about five guest speakers this year [whose topics ranged] from solar energy to the electron microscope. We went up to [the] college to see the electron microscope. We have sort of a strange, wild party at the end of the year where we go out and pick wild things and make a meal out of them, which is sort of neat.

Students also felt that the case study teacher had made a special effort to discuss science careers in class. As one student stated:

> She has gone over certain careers for different fields and what it would take to get into those careers and what it would be like working in them.

Another student commented on the types of careers they have learned about.

> There are many different varieties. We talked about scuba diving one day and about being in engineering and about getting into solar energy.

The students interviewed were all interested in science-related careers; one in marine biology, one in engineering, and one in biology. All of these students had either taken or were planning to take chemistry and physics. Furthermore, the students felt their mathematics classes had been and would continue to be useful. As one said,

> I have taken four years of math and it is very useful. I couldn't get through physics without it.

In general, the students interviewed had received encouragement and support from both family and friends for science career plans. As one girl explained,

> [They] think it is pretty neat that I want to do that [marine biology] rather than going out to be a secretary or something.

The three young women interviewed were cognizant of the unequal numbers of male and female scientists. One student explained the presence of fewer women in science by stating that "...women haven't really been encouraged to do things in that field."

The students also had definite ideas concerning the status of women scientists. As one put it,

> There are different fields that interest different people and it doesn't matter what sex you are if you are interested in something....I think it is very good that women are getting into science because it used to be considered a purely masculine field and men just didn't think women had the brains to be scientists. And that is not true.

The young women in biology courses at the high school do not perceive science as a masculine field. Part of this perception must be attributed to the enthusiastic role model presented by their female biology teacher/ balloonist, pilot, scuba diver!

VI. TEACHER/STUDENT INTERACTIONS: CLASSROOM OBSERVATIONS

Observation Session 1

The class performed a laboratory exercise on digestion. Since the exercise was adapted from the Blue Version of the BSCS, the directions for the lab were written on the chalkboard. The students were divided into teams by rows with a volunteer from each row selected as team captain. The row arrangement for team organization resulted in juniors and sophomores combined on the same team.

The necessary apparatus for the teams had been placed at the end of each lab table. The teams were given a few minutes to discuss each part of the lab with someone from each team presenting a review of the concepts important to his/her part of the lab.

The team assignments were by rows:

Team #	Substance added to dialysis tube placed in a test tube.	Substance added to the test tube.
1	Starch solution	Iodine solution
	Iodine solution	Starch solution
2	Glucose	Water
3	1/2 starch; 1/2 diastase	Water
4	1/2 starch; 1/2 saliva	Water

With some prompting from the teacher, the concepts of osmosis, diffusion, reusability of enzyme, and rate of reactions were reviewed by the students. It was difficult to get the students to explain without prompting that the dialysis tubing represented a model of a cell membrane. Simple facts such as "iodine is a test for starch" or " Benedict's solution is an indicator of sugars" were readily offered.

The students were accustomed to this procedure and started the lab independently. However, there was some delay as no one on Team 4 wanted to provide the saliva. Their team captain finally volunteered. Each team had been asked to predict what would happen in their experiment, to obtain a consensus for a hypothesis, and to write a group conclusion. Any member could present a dissenting opinion. When the noise level in the room got a bit high the teacher closed the door as the conversations appeared to be about the lab exercise.

There were three female captains and two male captains; there are more girls in the class than boys. The girls appeared to be quieter in getting the team to complete the task and more efficient in their final results. Perhaps the girls who volunteered to be captains were more capable; the boys just seemed to want to be in charge. The teacher circulated around the room giving assistance when asked, but usually probing with a question rather than providing an answer. These classes are a combination of juniors who have had chemistry and sophomores who have not had chemistry. At times it was difficult for the sophomores to understand the concepts. There was good cooperation as the older students helped those who were having difficulties.

At the conclusion of the lab a representative from each team presented his/her team's data, and members of the team answered questions. Following the discussion, the teacher gave a short, ungraded quiz on the concepts.

Observation Session 2

Each student had been given a copy of two pages of genetics problems for homework and all questions on both problem sets had been discussed in class. Three captains were selected by the students. The captains took turns selecting team members. Students tended to be selected on the basis of their knowledge of genetics rather than popularity, although friendships did prevail in a few cases. There were two female captains and one male, but the sex distribution was about equal on the three teams.

The members of each team were given numbers. The teacher informed them that the winning team would be the one with the highest number of points for answering the questions. To win, each member of the team must be able to solve all the genetics problems so the students who understood genetics the best should work, either as a team, or one-on-one to be sure everyone could solve the problems. The teacher told them she would call out a number at random and the member of each team with that number must be the one to go to the chalkboard to write out the complete answer. Also selected at random would be the particular problem to be solved. The team member who had the correct answer on the chalkboard first would earn a point for his/her team. The students were given 20 minutes to coach each other.

During the 20-minute coaching time, the teacher was available to answer any questions. One team captain assigned good students to work with the weaker students. Another team covered the more difficult questions as a team. The third team tried to go over all of the questions in the 20 minutes as a group. At times each of the teams varied their plans as individual members prevailed. They asked the teacher questions, but most of the learning occurred within the groups. Learning did take place as no one wanted to let the other team members down.

Since there were more girls in the class and the girls in this class were the better students, there was little sex-role stereotyping. At times, however, the girls appeared to defer to the boys' opinions.

At the end of the 20-minute study period, the teacher began the competition. Interest was high and the students cheered their representatives on. Fortunately, the room is at the end of the hall and a storage room separates it from the next room. In a few cases, students were studying other questions in case they were called on rather than entering into the spirit of the competition. Fortunately, the scoring remained close until the end; this kept the interest level high. The students indicated that they enjoyed this type of activity and would like to do it again.

Observation Session 3

The teacher handed back a genetics quiz. There was the usual exchange of "What did you get?" One girl, who had received 100%, was given permission to work on a project in the science office. The teacher discussed each of the problems, asking if anyone wanted her to go over each question. Someone asked for an explanation of most of the questions.

She asked for volunteers to put the answers on the chalkboard. Both boys and girls volunteered. The first nine questions concerned the correct parents for three babies whose name tags had been misplaced because of fire. This led to a discussion of the legality of using blood types, and other genetic factors, to establish paternity. The boys tended to feel that this method was not certain enough to be legal, but the girls disagreed. Each side was given a chance to present his/her side. However, the boys were louder in voicing their opinion.

Several students who had obtained the correct answer to a question by guessing asked for an explanation. Those who understood the questions were patient with those who did not. At one point, when a student did not understand the explanation, the teacher asked another student to explain it. When that did not help, the teacher put the problem on the board in a step-by-step sequence.

After completion of the discussion of the quiz, several students asked questions about a lecture on Genetic Engineering that they had attended at Colby College the previous evening. This topic seemed to interest quite a few members of the class. Two students have mentally disabled brothers and asked questions relevant to their own situations. One student felt that genetic engineering was wrong. A boy who had attended the lecture the previous night pointed out to her how it might be beneficial.

The question of "test tube" babies arose. Most of the students favored that procedure. The teacher allowed them to discuss this issue among themselves for a few minutes. Some of the students left the room discussing the topic as the period ended.

The assignment for the next day was on the chalkboard and had been explained by the teacher at the beginning of the period. The teacher did not appear to differentiate between the boys and the girls and made no comments that would suggest sex-role stereotyping.

Topics of Special Interest Among Female Students

Although the instructor argues that you do not need special activities to interest girls in science, it is possible that for the less-motivated girl certain labs and/or research projects are more appealing. For the home economics, non-science-oriented girls, experiments such as audio-tutorial units on bacteriology have considerable appeal as they require careful measurement. Students can also complete this exercise at their own pace.

Nutrition and diets appeal to many girls. A unit on "Complementary Proteins: A Simulation" has appealed to many girls, especially girls who are on or are contemplating a vegetarian diet. Similarly, "Dissection of an

Orange" is very popular with many students. It came from the first chapter of the ORM Involvement in Biology Today. Complementing these is a lab which was given to the teacher when she spoke at an International Science Conference. "Nutrition - An Organic Necessity" is a dry lab where the student gets immediate feedback via a response indicator. Afterwards, all students are asked to complete the single sheet "Is It Safe to Eat Anything, Anymore?" and most of them love doing it.

Probably the most successful lab of the year is an adaptation of several labs a professor introduced to the high school science center students. Students complete chorio-allantoic grafts in chick tissue culture. Local hatcheries provide a number of fertile eggs.

The teacher feels that the girls' interests are as varied as those of the boys. Last year a girl designed and built a windmill for a local garage and another girl spent hours assisting a vocational teacher who is building an airplane. Although it varies from year to year, there were three girls who attended a two-day Symposium in Science this year. There were also more girls than boys attending the local college's Biomedical Symposium.

All seating and lab work is completely irrespective of sex. The teacher attempts to be fair so that the first person who volunteers to be a lab captain is the person chosen. When the lab requires the use of heavy equipment the girls are not given special consideration. However, since the beginning of this study the teacher has been more alert to the possibility of any sex bias in her teaching.

VII. TEXTBOOK ASSESSMENT

The text currently in use is Modern Biology, Otto, J. H., A. Towle, & M. E. Madnick. New York: Holt, Rinehart & Winston, 1977. The case study teacher does not like this text very well, therefore, each of her students is also given a copy of the BSCS Blue Version and the BSCS Yellow Version. The BSCS texts are used for extra credit opportunities.

Citations may be attributed to 99 male authors but only 21 female authors. However, since only initials were given for 23 contributors, the sex of 23 authors cannot be determined.

Diagrams used male figures except for one diagram which showed the endocrine system of both a male and a female. Photographs of professionals in the biological sciences were more evenly distributed between the sexes; 53 males and 46 females were shown.

Case Study G

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I. THE COMMUNITY

The community that is the site of this case study is a city of approximately 300,000 people in the Rocky Mountain West. The socio-economic status of the residents is variable but is, in general, middle-class or upper middle-class. There is little heavy industry; the primary economic base is a mixture of service and high tech industries. There is also a heavy military influence. There are three major military installations in or near the city. Local and state governmental policy are supportive of the high tech firms; the influence of that section of the business community is growing rapidly and is unlikely to abate in the foreseeable future, although the Chamber of Commerce reports that the service industry is presently the most significant sector of the city's economic base.

As is the case with many cities in the West, this city is experiencing unprecedented population growth. That, of course, is both a blessing and a curse. The rapid growth has, to some extent, insulated the economy from the extreme effects that other parts of the country experienced during the current recession. For example, unemployment is approximately 3% below the state-wide average of 8.7%. Fifty-three percent of businesses surveyed anticipate hiring new employees during the third quarter of 1983. The cost of living is 96% of the national average.

The relative strength of the local economy is particularly evident in the housing industry, which continues to build single-family homes, condominiums, and townhouses at a rate that gladdens those in the associated industries while creating the deepest consternation among those who wish to see a more reasonable and reasoned growth policy.

The community is relatively stable. The military presence, however, does create a rapid population turnover in some sections of the city, a situation that creates problems for the schools in those areas. While rapid growth of high tech industry in some locales results in a decrease in community stability—owing to the volatility of that industry—the economic development department of the Chamber of Commerce does not expect a similar loss of stability in this city. The department attributes that to the desirability of the area. The ethnic base of the community is solidly Anglo. The minority population in the school district that is the subject of the case study is 19% Hispanic; 12% black; and 1% other. That is generally reflective of the community.

The predominant religions are the various denominations of Protestantism, and the religious community in general is quite strong. There appears to be an active fundamentalist community, a fact that is consistent with the conservative political nature of the city, which itself derives from the strong military presence and the simple fact of Western tradition. One district in the city has experienced a long and contentious series of challenges to textbooks and curriculum. These challenges—directed as "secular humanism"—have been orchestrated by the conservative, fundamentalist segment of parents in that district. The city's voters consistently send conservative representatives to Congress and support consistently the more conservative of the state's United States Senators.

The city is, in general, quite an agreeable place to live. The geography, climate, and relaxed life style provide and promote outdoor recreation. The cultural activities of the community are quite good and probably exceed those of most other cities of comparable size. One college, one branch of the state university, and one community college contribute to the cultural base of the city, and the public is quite supportive of all cultural activities.

II. THE SCHOOL

The school district in question is in the heart of the city—the oldest part of town. Thirty thousand students attend a total of fifty schools: 35 elementary schools; 10 junior high schools (grades 7-9); and 5 high schools (grades 10-12). The district is accredited by the North Central Association of Colleges and Secondary Schools and by the state.

The socioeconomic status of the families who live in the district is mixed and is reflective of the general demographics of the city. The district is comprised primarily of one-family homes; more than 50% of the families have two incomes. The 1983 mill levy for education was 55.526 mills.

The seven-member school board includes three females, one black, and one Hispanic. The district director of information services reports that there is generally high community support for the district, with 2,800 community volunteers active on a regular basis. There are two parochial schools that, according to the director, have minimal effect on enrollment. There is some cross-fertilization among the faculty and students of the district schools and the colleges in the city.

The high school in question is the oldest in the city, built during the first decade of this century. During the 1982-83 school year, grades 10-12 accommodated a total of 1,102 students. Busing was available to approximately 65% of those students, although the number actually being bused was much less, because many students chose to drive. The school has no special features that distinguish it from any other high schools in the district, but it is considered the district's inner city school, because the minority population in this school is greater than that in the others.

There are seven full-time teachers in the science department, six males and one female. There is also one part-time female. Five people teach biology, although only one teaches biology full-time; she is the subject of this case study. Three males teach chemistry, one male teaches physics, one male teaches geology, and one male teaches physiology. For the last 16 years the department chairman has been a male. The only female department head in the school runs the business department.

Students are required to take one year of a laboratory science and most fulfill that obligation by taking biology. One year of math is required; ninth grade math fulfills that requirement.

III. THE SCIENCE CLASSROOM

There is little in the way of special equipment for the science department. I noted three centrifuges, one spectrophotometer, one new egg incubator, various microscopes and stereoscopes, and a kymograph. The school does have several microcomputers, but none is available to the science department on a full-time basis. While the science department is trying to get its own computer, there is as yet no obvious attempt to integrate computer-based instruction into the biology curriculum.

The science classrooms are together in the basement of the building. Each is large, with rows of chairs in front to accommodate didactic instruction, and lab tables in the rear to accommodate laboratory exercises. All of the classes I observed were held in the same room; the walls, bulletin boards, and black boards were covered with displays of many types. Instructional models and displays were scattered throughout the room.

IV. THE SCIENCE TEACHER

The teacher who is the subject of this case study, has been teaching at the high school for 16 years. After receiving a BS in zoology from a Big 10 university in 1966, she explored several fields related to biology, including scientific information specialist and nursing. None was satisfactory, and she returned to the same university to receive an MS in the teaching of biology. In this experimental program she was exposed to an influential supervising teacher (male) who was very supportive. She describes him in the following way:

> I got a really outstanding, cooperating [supervising] teacher. [He] only gave me three classes. He wanted me to prepare and feel comfortable. His philosophy was [you should] see if you like teaching, or can teach. He was very supportive of me. He was the key.

His influence was sufficient to convince her that teaching is a worthwhile and productive profession, despite her earlier assertion that she would never become a teacher.

She says that her teaching strategies and expectations have changed considerably from her early days at the high school. She was, in her words, "rigid and structured," and concerned with "covering the material." She says that her general goals for her biology students are that they:

1. learn the process of science, that is, solving a problem, a skill that she says is transferable to other disciplines,
2. learn the facts of biology, and
3. appreciate the role of science in society and understand the relationship between science and technology while being able to understand the difference between science and technology.

She has long expected students to work individually on all problems, but she now sees group problem-solving and brainstorming as more productive. Therefore, she now permits group work and group reports where "the smart kids help the others."

She feels she has had good support from the administration during her tenure at the school but is angry that "a shortage of science teachers does not create as much concern among the public as does cutting the football budget." The shortage of science teachers has forced her to give up two special interest courses, one in genetics, the other in animal behavior. She still teaches one advanced placement biology course, and "works really hard" to get female students into the course:

> I think it is ingrained in females that they don't have to take any more science. I work really hard...getting girls into science. All the male [students] want to take AP chemistry. The teachers tell them that this is the really hard course; this is the course for the men. I think [the female students] get a little scared.

While she perceives an increased interest in science among students, her students are, nonetheless, not very interested in careers in science. She says:

> I find it rare for students to say they want to go into a field of science. They are almost afraid to say that in front of their peers. I suppose they think the kids will make fun of them. They like to be like their peers.

She does indicate that this lack of interest is not a problem in her advanced placement courses.

She indicates that there is no concerted effort to discuss science careers with her students. She indicates that that may be due to the fact that "we feel very content-compelled." My opinion, based on five separate class observations, is that her opinion is entirely accurate. Most of the instruction is didactic, emphasizing recall and straightforward structure/function relationships. While she and the students ask good questions, there is generally little opportunity for extended inquiry either in the class discussions or in the laboratories. It is my opinion that this is largely a function of the textbook which is heavily content-oriented and expository. Marge indicates that she feels a great need for open-ended labs, but that the time constraints do not allow for planning or completion of such activities.

The case study teacher belongs to several professional science teaching associations, although she does not attend the meetings and does not feel as if either organization has played an important role in her professional development. In general, she does not read articles related to improving one's teaching skills. She does read extensively in the areas of wild life biology and nutrition and incorporates that information into her teaching. She noted that the traveling she does during vacations makes her a better teacher:

> We went to Australia and Fiji. I [studied] the tropical vegetation of the areas. I find that I become a lot more vivid teacher in the classroom. I will tell [students] what it is like to almost step on a sea urchin, or have a fish come face to face with me. They love that kind of thing. They want a real person in the classroom.

V. THE CASE STUDY STUDENTS

Student interviews confirmed that there is little overt attention given to discussion of careers in the classroom. One student in advanced placement biology indicated in her interview that it is an implicit assumption that the students in that class will be going into some science-related career. A number of the students addressed their own math anxiety as a reason for not considering science careers. While all students indicated that the instructor is generally accessible after class and after school for issues of a personal nature, only one indicated that she had spoken with the teacher informally about science careers.

The case study teacher indicated that students think scientists are "stuffy people." Further, "they associate science with math...that shuts out science." That assertion is confirmed by interviews with five of her students; each noted the math-oriented nature of science and expressed doubts about her own ability to do that work. The students interviewed had a fairly stereotypic notion of science and scientists. One student was able to contrast her "romantic" image of a scientist with a more realistic perception:

> The more romantic [image] is [a scientist] finds new things...and sees that there is something more to it than what somebody has already found. They take what has happened in a reaction and say, 'Oh, well, that means that this and this is the cause.'
>
> [The more realistic image is] they're constantly checking things out, putting things under microscopes, and searching and looking. It entails a lot of writing and going back over what they have already done. Doing it again and again and again A lot of repetition.

Another student indicated that scientists are "every day, human people," but she still has a perception of scientists as people who are "always working in a laboratory."

None of the students identified scientists as role models and only one identified a science-related career as her profession of choice. There was, in fact, a surprising lack of role models in general among the students interviewed. All of the students interviewed were attentive to the changing roles of women in society, and to the fact that women are more likely to be active in science careers now than they were even ten years ago.

One student was particularly perceptive in explaining why this has happened. She attributed it to women's increasing desires for independence. She cited examples of women who are no longer content to stay home and raise families and of women who are divorced and wish to have secure, rewarding, and well-paying jobs that enable them to support their families. She also mentioned the effect of the movement for the Equal Rights Amendment on women's perceptions of themselves. A student in advanced placement biology, however, said:

> Women can be anything they want to be [but they] are going to have a harder time with [science]. There are still some people who automatically doubt the capabilities intellectually of a female. Most people think the way they do because of the way they were raised...the train of thought is...women are physically inferior, therefore mentally inferior, and not capable of many things. I think... attitudes are definitely passed down.

She was the only student who indicated that female scientists might have to work harder than male scientists to attain the same level of recognition and that such women are probably "superior" because they had to "fight to get there."

There were many other such comments from the interviews that indicate what is, to me, a surprising degree of insightfulness among these students. One senses that these students are beginning to struggle with some very difficult societal problems, that they are becoming quite sensitive to the complexity of those problems, and that they understand that the solutions will be equally as complex. That is, admittedly, a very liberal interpretation of what I heard in the interviews. Nonetheless, I was impressed with the sensitivity of these students and with their obvious skill as observers of societal trends, notwithstanding that their analyses are somewhat linear and unsophisticated.

VI. TEACHER/STUDENT INTERACTIONS: CLASSROOM OBSERVATIONS

I observed three classes of general biology and one of advanced placement biology. Table 1 gives the distribution by gender of the students in each of the classes observed.

TABLE 1. Distribution of Students by Gender

Date of Observation	Class	No. Males	No. Females
1 April 1983	General Biology	11	11
5 April 1983	General Biology	9	10
8 April 1983	General Biology	7	12
20 April 1983	AP Biology	5	4

It is quite clear that the instructor is an effective teacher. Her command of the material is excellent; student interviews confirm that she is knowledgeable and well-prepared. Students also commented on her willingness to say "I don't know" in response to student questions. I observed that response on two occasions and was myself unable to answer the questions satisfactorily. Students indicate that in such situations the case study teacher generally returned with the answer the next day. She uses a variety of teaching tools to supplement her lectures and labs, including films, models, charts, and clippings from newspapers and magazines.

Male and female students respond with equal frequency and with equal quality to questions posed by the teacher or by other students. The questions generally involve recall answers; there are few inquiry-oriented questions. The teacher does not favor male students over female students or vice versa. In only one instance did a male student seem to be dominating discussion by responding continuously to questions.

Only once during my observations was there a discussion of science-related careers. That was a follow-up to a presentation to the class by a radiologist. One female student indicated that she would like to be an X-ray technician;

another indicated that that would be "too boring." In response to a general question posed by the instructor, one female and two males indicated a general interest in science-related careers. The case study teacher indicated in her interview that information about careers is generally conveyed "informally," when certain topics are covered.

It is difficult to isolate those factors that contribute to her success with female students. The classroom is a complex environment, and the students bring to the classroom so much in terms of prior experiences and preconceived notions that it is difficult to differentiate between cause and effect. Certainly, she is competent, and while none of the five students interviewed cited her (or anyone else) as a role model, competence is always a good model. There is also the obvious, mutual respect between the teacher and her students; they clearly like one another.

I was unable to identify any activities or teaching strategies that are especially designed to encourage girls to take more science courses or to enter science-related careers, save for the teacher's statement in the interview that she "works hard at that." All students, regardless of gender, are expected to contribute equally to the class and to participate fully in all labs; there are no differential expectations for male students as opposed to female students. There is no overt discussion of sexism that might be inherent in any of the instructional materials used by the instructor, as none of the materials seem to present that problem. Five tests were provided for analysis. There appeared to be no problem with sexist language; scientific contributions were treated as neutral relative to gender.

Perhaps the equitable treatment of male and female students is itself special, given what has been learned about the generally inequitable treatment of female students in the science classroom. Perhaps the simple lack of preferential treatment for males has resulted in a situation where the female students feel comfortable and are confident in their ability to contribute at an equal level with their male colleagues. Certainly, there is not enough data to support that hypothesis, attractive as it might be.

I think that rather than identifying a teacher who consciously encourages females in science, we have simply identified a very good teacher, whose talent, commitment, and rapport with her students combine to make the study of science an interesting and enjoyable endeavor. I am hard put to suggest any more direct cause and effect relationships, because the data will not support them, any more than the data will support more than a broad philosophic argument for the generalizability of her teaching approach to other classrooms.

While I have contributed little to a clarification of those traits or activities that encourage females to pursue science-related careers, I have come away from this case study with renewed belief that content-laden instruction is not conducive to attracting students-male or female-into the sciences. The portrayal of science as an aggregation of loosely related facts and terms is misrepresentative of the nature of all scientific disciplines and misconstrues the way scientists work and what they hope to accomplish. Until science instruction incorporates more of the open-ended laboratories that the teacher argues for, until the text becomes a resource rather than the immutable template for the replication of redundant information, and until most students can see the relationship of science to their own lives, science-related careers are likely to remain singularly unappealing to the majority of students.

VII. TEXTBOOK ASSESSMENT

The text in use was Modern Biology, by Otto and Towle, New York, Holt, Reinhart, and Winston, 1977. The accompanying laboratory manual is Laboratory Investigation in Biology, by Otto, et al., Holt, Reinhart, and Winston, 1977. Modern Biology has long been the single, most widely-used text in high school life science. It is well known for its straightforward, didactic presentation of facts and vocabulary. It is not noted for an emphasis on process or inquiry skills. The problems inherent in a content-heavy text are compounded by the 1977 copyright date, which, through no fault of the authors, renders much of that content obsolete or imprecise. That, however, is a universal economic fact of life for most school districts. This situation that is likely to be exacerbated by the fact that the economic exigencies of school boards and the publishing industry now appear to encourage publishers to revise every seven years rather than every five, which is currently the case.

The course is organized around the basic text; there is little ancillary material. I found the narrative of the text to be generally free cf sexist language. Throughout, the terms "people" and "human-beings" are used in place of "man." There does not appear to be an abundance of male pronouns, nor is there any indication of stereotyping of females. The book does not fare as well, however, in its treatment of the contribution of women scientists.

Table 2 details the number of male and female researchers and students in text illustrations. Of 35 such illustrations, 21 (60%) were of males and 13 (37.14%) were of females. One illustration, that of a scuba diver, was indistinguishable in terms of gender.

TABLE 2. Number of Male & Female Researchers & Students in Text Illustrations

		Number	Percentage
Male		21	60.00
Female		13	37.14
Indistinguishable		1	2.86
	Total	35	100.00

The book does not specifically address careers in the biological sciences. There are, however, pictures of individuals involved in various work-related situations. Table 3 lists the jobs or careers where women are portrayed or described in the text.

TABLE 3. Jobs or Careers Where Women are Portrayed or Described in Text

Veterinarian
Microbiologist
Medical Researcher
Nurse
Zoologist
Ethologist

Of ten photographs of women in science-related situations, six portray those women as being meaningfully involved; four depict women as essentially passive observers. Of five illustrations of notable scientists, four are of men; Walter Sutton, Luther Burbank, Edward Jenner, and Louis Leakey. Jane Goodall is the only female scientist of note whose picture appears in the text, along with a brief description of her work.

TABLE 4. Number of Male & Female Researchers Cited in Bibliographies (1), Index (2), and Illustrations (3)

	Number			Percentage		
	1	2	3	1	2	3
Males	108	35	4	69.23	87.5	80
Females	25	0	1	16.03	0	20
Indistinguishable	23	5	0	14.76	12.5	0
Totals	156	40	5	100	100	100

Table 4 delineates the number of male and female researchers cited in bibliographies, the index, and illustrations. There were a large number of indistinguishable entries in the bibliographies and the index. Those entries included only first initials, and while most teachers and others familiar with the field of biology would be able to identify those individuals, it is unlikely that students would be able to do so. The index is completely devoid of any references to females, a fact that reflects the poor treatment of the contribution of female scientists in the narrative.

Case Study H

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I. INTRODUCTION

Ten years ago, Berkeley sociologist Lucy Sells identified mathematics as the "critical filter" for women and minorities in educational and occupational advancement (1973). While dissemination of this idea fostered a national movement, particularly for women, that concentrated on enrollment in elective mathematics classes in high school, Sells' influence in the Bay Area was even more extensive. She approached the Lawrence Hall of Science, a public science center on the University of California, Berkeley, campus, and asked what was being done to address this problem. The initiation of an after-school class called "Math for Girls" in 1974, the founding of the Math/Science Network in 1975, and the first "Expanding Your Horizons" conference for young women in 1976, can all be traced to this impetus. Since that time, a number of programs have been developed at the Lawrence Hall of Science that have focused their energies on mathematics, both for its own sake and for the role it plays in the educational opportunities in science and engineering. Thus, in the Bay Area, a search for a teacher who is instrumental in the advancement of women in science is likely to uncover a teacher of mathematics. The subject of this study is such a teacher.

The city is located on the West Coast. Its school system serve a majority of minority students (59% consisting of 40% Black, 8% Hispanic, 7% Asian, 3% Filipino, and 1/2% American Indian). The students' parents are better educated (59th percentile in the state) than they are wealthy (91st percentile in receipt of Aid to Families with Dependent Children). Despite low performance on statewide tests of written expression (34th percentile) and mathematics (39th percentile), nearly as many of the school district's students (51%) attend public post-secondary schools as the state's average (58%).

There are six high schools in the city. The case study high school enrolls 1,424 students and has the highest minority student enrollment in the district (79%, consisting of 65% Black, 3% Hispanic, 9% Asian, 1% Filipino, and 1/2% American Indian). The students' parents are better educated than the district average (70th percentile in the state) though not substantially more wealthy (88th percentile in receipt of Aid to Families with Dependent Chidren). While students at the school perform poorly on the statewide tests (26th percentile on written expression and 22nd percentile in mathematics), those who take the Scholastic Aptitude Tests exceed the district average (verbal 441, math 483). Since approximately 40% of the seniors (123 of 297) take the SAT, it is clear that the school has a very diverse student population. Yet it manages to send a high percentage of students to the highly selective state university (14% of the school's graduates, compared with 9% in the district and 6% statewide). An additional 23% of the school's graduates enroll in community college programs, somewhat lower than the district average of 29% and the state average (42%). And those who attend selective colleges bring with them a total of 39 Advanced Placement Exam scores at 3 or better (5 in American History, 19 in English, and 15 in mathematics (B/C) — no significant difference between male and females). What accounts for such a strong college preparatory program* in an urban, minority high school? While a concentrated effort of faculty, administration,

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*The curriculum includes the following college preparatory courses: U.S. History, American Government, Advanced Placement U.S. History; English 1-4, Advanced Placement English, Oral English, Philosophy Literature, Advanced Essay; Introduction to Algebra 1, Geometry, Algebra 2, Math Analysis, Calculus-Analytical Geometry; Advanced Biology, Chemistry, Physics, Physiology; French 1-6, German 1-4, Spanish 1-6.and students is clearly in effect, the case study instructor is at the center of activity.

The case study teacher grew up in the deep South, where her mother and aunt both taught school. The family moved to Atlanta, Georgia, where she attended high school and college, majoring in mathematics. She started teaching mathematics in a nearby city, but later moved to her present residence. After working for IBM as a Systems Engineer, she began teaching in a local junior high school in 1968. Required to resign her position during pregnancy, she returned to teaching as a long-term substitute at the high school and achieved a full-time position in a combination math/English program in 1970, since she had a minor in English. Finally a full-time mathematics position opened up, and the case study teacher has been a math teacher at the case study school ever since.

II. ALGEBRA 2 CLASS

The instructor currently teaches Algebra 2, Geometry, and Math Analysis. The Algebra 2 class was the focus of this investigation. The class is held in a large room that is actually two small rooms with a divider. When the school had modular scheduling, classes could be team taught with two lectures and two discusisons per week. There is no modular scheduling now, but the same clases cover the same material in the same period of time — assignments, quizes, and tests are given at the same time in each class for the same course. The teacher has organized her classes so that students have some flexibility. When she lectures or goes over problems, she allows those who want the opportunity to work by themselves or in groups in the back of the room. The class as a whole and the small groups are fairly balanced by gender, and are mixed.

Observers in three class sessions found that the case study teacher treats all students with respect. To quote from the summary field notes:

> [She] treats all individuals with respect, not only across sexual and racial lines, but also across age and 'rank' lines. She made several comments that indicated that she does not stress her authority as teacher. Her beginning 'disciplinary' comment for her lecture was, 'Can everyone hear me who wants to?' and, of course, the fact that students come and go out of the lecture group and class seemingly at will exemplify this

> respect for her students. Even in disciplining the independently working group when they were too noisy, she gave them the choice, 'You guys either get closer together or work by yourselves — that's okay, too,' or 'You'll have to join my group.'

The instructor does not, however, let some students get left out of the process. On one occasion when males were dominating the discussion, she said, "I need to know if she knows...," referring to a female who had asked the original question. On another occasion, she told a female student who got an answer different from the book, "Don't let the book shatter your confidence. Trust yourself." While males more often answered questions spontaneously, females were continually incorporated into discussions.

Former students substantiate these observations. They said, for example, that they don't ask many questions because other people usually ask what they want to know and that the teacher explains thing pretty well. Another student reported that one felt more comfortable asking her questions than some of the other math teachers, as this teacher was helpful when she asked for help. Another student characterized the case study teacher as a good instructor meaning having a sense of humor, willing to help, and doesn't make you feel dumb about asking for help, good at explaining, and takes an interest in students. Finally, a former student indicated that she appreciated the fact that this instructor doesn't just do the problem for you, but make the whole class participate.

Interestingly, former students were not difficult to locate. The State Office of Student Research was able to supply names of former students now attending their institution and indicated that the case study teacher and another teacher were cited on an entrance survey by seven of the school's freshmen as being outstanding teachers. These leads did not have to be followed, however, since our study teacher was able to name several former students who had pursued science fields and to provide information to locate them. Thetask was also simplified by the fact that one former student was one of the researchers. The fact that former students stay in touch with the case study techer and remain interested in the high school speaks to the strong sense of community that is created there.

III. TEXT

The text for the Algebra 2 course is Modern School Mathematics: Albegra 2 and Trigonometry by Dolciani, Wooton, Beckenbach, and Sharon; Houghton Mifflin, 1968. The Dolciani series is the most commonly used series in the U.S. (Weiss, 1978). An analysis of the sex-bias in the text presented in Tble 1 shows that the vast majority of the content is sex-neutral, making no mention of male or female names or pronouns. Over 99% of the oral and written exercises and 80% of the (word) problems are sex-neutral. Of such material containing references to gender, however, the ration of male references to female references ranges from 2.5:1 for written exercises to 17:1 for (word) problems. This imbalance is not nearly as disheartening, however, as the "Biogrphical Notes" and "Careers in..." sections.* One hundred percent of the former and 85% of the latter are male.** While the 1968 publication date of this text precede prevalent attention to sex and ethnic representation in curricular materials, its lack of female and minority references, especially in career areas, necessitate supplemental work on the part of the instructor. Such activitie as MESA, EQUALS, and Expanding Your Horizons, have assisted the case study teacher in this endeavor.

IV. MESA

The Mathematics, Engineering, Science Achievement (MESA) program was begun in 1968 at the University of California, Berkeley. It was designed to increase the number of minority students who graduate from high school with adequate preparation for undergraduate majors in mathematic-based fields. It provides tutoring and study groups; academic, college, and career advising; summer programs; and scholarship incentive awards. In exchange, it requires that students complete three or four years of college preparatory mathematics, four years of English, and chemistry or physics.

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*The Teacher's Guide for the text explains that these sections supply the motivation for students, and it appears that such motivation may not be equally effective.

**It should also be noted that none of the people described or pictured is a member of a minority group.

One of the earliest high schools to participate in MESA was this high school, and the teacher has been the MESA advisor since 1972, making her the longet serving advisor in California. She cites her long tenure as an advantage, saying: "I'm fortunate that I've been here so long because now I'm having my own graduates come to speak to (the MESA students). And these kid, some of whose brothers and sister they know, are just ordinary kid to them. So they say, 'You did it, I can do it, too.' It makes a difference. As a result of her MESA involvement, she was interviewed by a national news magazine about the national teacher shortage in math and science.

V. EQUALS

EQUALS was started in 1977 at the Lawrence Hall of Science, University of California, Berkeley. Originally designed to increase the enrollment of women in elective mathematics courses, EQUALS has expanded its objective to emphasize participation and achievement of women and minorities in mathematics and computer science programs. EQUALS provides teachers and other educators with materials and strategies to make students aware of the importance of mathematics and computer proficiency, to increase their competence in problem solving, and to provide encouragement to persist.

Teachers from Bay Area districts have been eligible to attend EQUALS workshops since 1977, and the case study teacher attended as a participant in 1978-79. She has returned several times since then as a role model, to speak to teachers as colleagues about the way in which she's implemented EQUALS ideas. She felt that EQUALS opened her eyes — "I guess being caught up in the problem of minorities being left out of many opportunities, because of unawareness, I wasn't as conscious of the women's problem..." Her contributions have further inspired other teachers to put EQUALS strategies into practice.

VI. EXPANDING YOUR HORIZONS CONFERENCES

As part of the EQUALS participation, she was introduced to the Expanding Your Horizons conferences which have been sponsored annually since 1976 by the Math/Science Network. These conferences aim to increase young women's interest in mathematics and scinece, to foster awareness of career opportunities in math- and science-related fields, and to provide students with an opportunity to meet and form personal contacts with women working in traditionally male occupations.

VII. THE SCHOOL CONTEXT

The city's unified school district only requires that students complete one year of mathematics for graduation, yet at the school studied it is clear that most go beyond this requirement. Of those taking the SAT's, the mean number of years was 3.64 for male, 3.36 for females, with a mode of 4 years for both in 1982. This situation is not only a result of the case study instructor's efforts, but also those of other teachers. As she says, "It's a team effort."

An important ally in the effort to make sure that all student achieve their potential is a colleague of the case study teacher. Currently teaching physics, calculus, and computer science, he has also taught chemistry, horticulture, and all the basic mathematics courses in the 16 years he's been at the school. Perhaps the most revealing comment that he makes is this:

> We're not doing anything to encourage (girls), aside from just telling them to take the class, encouraging them to take the classes and talking to them individually. And I do a lot of that. I do go around asking them what they're going to do....If they say they're not going to be going into science I try to encourage them a little.

Given such a position, and such humility about it, it's not surprising that girls at this school succeed.

Another science teacher, who teaches biology says that the way they encourage students is, "Hard to say; partly because the whole science department is a team." He, too, can name students who have gone on in math and science careers. With obvious pride he said, "At one time we had six people at MIT." After naming students at UC Berkeley and California Institute of Technology, he said, "The list goes on and on."

This position is in contrast to that of the guidance counselors. The one we interviewed said that the gender equity project from the district office, "is a dead horse." When the interviewer asked about the traditionally stereotyped Development Center Bulletin, she was told, "But this is a different level, it's a different picture." When asked how they encourage students to continue in math and science, the counselor said, "They really make their own decisions."

VIII. SUMMARY

It is impossible to say what factors are responsible for the relative success of the school's mathematics and science programs in general and the case study teacher's mathematics teaching in particular. It is likely that the overall school context, which supports students who achieve academically; the team effort of mathematics and science teachers; the special programs such as MESA, EQUALS, and Expanding Your Horizons; and the conscientious teaching of the case study teacher all work together to bring about this result. Making sure that all students in a class have a chance to succeed and are encouraged to persist are by themselves unremarkable characteristics of a teacher. Coupled with support from colleagues and the greater community, however, she has parlayed them into remarkable success.

Former Students of Case Study Teachers

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INTRODUCTION

Former students of each case study teacher were surveyed by mail; the surveys were returned directly to the principal investigator. They were chosen because they were science majors in college or were pursuing science-related careers. Although a bias was present in their selection (all were recommended by either a case study teacher or a counselor), their answers were completely confidential. Therefore, they could be as frank as they wished in responding to questions concerning their choice of science careers, their future plans, and their past incentives.

Sixteen young women and three young men responded to the mailed survey. Their average age was 22.4 years +/- 5.13 and 89.5% were unmarried. Only 21.1% of the respondents were not students. Fifty-seven and nine-tenths percent were full-time undergraduate students, 10.5% were full-time graduate students, and 5.3% were part-time graduate students. The majority (78.9%) were studying biological sciences, while the remaining respondents were pursuing engineering, chemistry, or agriculture courses.

PRIOR EDUCATIONAL EXPERIENCES AND FUTURE PLANS

All of the respondents attended public/state-supported high schools and went to college immediately after high school graduation. Over half (63.2%) attended state-supported colleges or universities. Only 21.1% attended private, non-sectarian colleges, while 15.8% were enrolled in private, church-related institutions.

The past students surveyed had very successful high school experiences. When asked to describe the grades they usually received in high school, 73.7% of the respondents said their grades were in the "upper 10%" of their class and the remaining 26.3% said their grades were "above average." In fact, the respondents reported an average high school grade point average of 3.73 out of a total possible of 4.00.

The respondents took an average of 2.58 honors or advanced placement courses during high school. Over 50% took honors/AP English courses, nearly 50% took honors/AP biology courses, and over 35% enrolled in honors/AP chemistry and/or social studies courses. On the average, the respondents had taken 7.48 years of mathematics from high school until the present and 42.1% enrolled in honors/AP math during high school.

Respondents were asked to indicate how many years of a variety of academic subjects they had completed from high school until the present. As indicated in Table 1, these former students had completed three to four years each of biology, chemistry, English, and social studies. Other responses showed that 52.6% of them had completed an average of 1.9 independent research projects and 10.5% had published research articles (average number of articles = 2.0).

Table 1

Average Number of Years Completed and Percentage of Students Liking Courses by Subject

Subject	Average No. Years**	% of Students Who Liked the Subject*
Algebra	2.00	100.0%
Geometry	1.00	66.7
Trigonometry	1.07	69.2
College Algebra	0.93	100.0
Senior Math	0.86	100.0
Calculus	1.14	70.0
Biology	3.64	100.0
Chemistry	3.14	85.7
Physics	1.14	63.6
English	4.71	76.9
Social Studies	3.28	71.4
Mechanical Drawing	0.14	100.0
Typewriting	0.86	66.7
Bookkeeping	0.14	66.7

*Includes only students who indicated they had taken the subject.
**From high school to present.

In addition to this impressive academic background, the former students of the case study teachers also described impressive future goals. Only 5.3% did not plan to continue their education beyond their current degree program. The majority of them planned further degree work in science. For example, over 20% plannned to pursue a master of science degree, 26.3% hoped to enter medical schools and earn M.D. degrees, and an additional 21.1% planned to study toward doctoral degrees in science. The remaining respondents planned to pursue master's degrees in art or business. Overall, 73.6% of the former students felt that graduate work in math and/or science would be required to meet their academic and career goals.

IMPORTANT FACTORS IN SCIENCE-CAREER DECISIONS

Former students were asked to indicate how important certain people, courses, and activities were in their decisions to pursue and their persistence in pursuit of science careers. Students responded on a scale from 1 to 5, ranging from 1 (very important) to 5 (not applicable). Students' responses were averaged, and these averages provided an estimate of the importance of various factors.

Several types of persons received high ratings (average rating <3) indicating they were important factors. Among the categories of people rated as very influential in science-career decisions were high school biology teachers (average rating = 1.74), in this case the particular case study teacher. These students almost unanimously (94.7%) felt that their high school biology teacher offered frequent opportunities for individual discussions and encouraged his/her students to consider further education. Furthermore, most of the respondents indicated that their biology teacher encouraged them to be creative and original (84.2%) and to explore many choices for post-high school plans (73.7%). None of the former students surveyed felt that their biology teacher treated students childishly or distinguished between course opportunities for boys and girls. Several students described their biology teacher as a role model.

> My role model was my high school biology teacher.... She helped me decide on a science career because she showed me the many different aspects of science and the many different opportunities science has to offer career-wise.

> I admired my teacher very much and became interested in a medical career.
>
> [My biology teacher] was (and is) an enthusiastic, challenging, and supportive teacher. He helped me see, in concrete terms (in concrete successes) that I could be successful in medical science. He is one of a handful of outstanding instructors I have had in college (Harvard) and high school.
>
> [My] biology teacher...taught me how exciting biology can be.
>
> I had a very good teacher who interested me in biology and made me want to show other children how interesting science can be.
>
> [My biology teacher gave] me support and guidance in matters of everyday living as well as my career decision.
>
> She was very kind and a very good teacher - a woman whom I respect greatly.

In summary, former students described their high school biology teachers as encouraging, inspiring, and very important in their decisions to pursue science careers.

The second and third most important people in career decisions were fathers and mothers (average ratings of 1.95 and 2.32, respectively). Some students said that their parents were their role models.

> My parents, especially my father, have been role models and mentors. My parents because of their values and points of view, and my father because of his scientific interests and what he's shown me in that area.
>
> My parents were role models, they influenced me in my career choice by supporting me in any way they could.

On the average, the parents of these young women and men were highly educated. Among the fathers, 31.6% had earned doctoral or medical degrees, 21.1% had earned vocational or business degrees, and 15.8% had received bachelor or master degrees. Over 10% of their fathers were employed as scientists, 26.3% as other types of professionals, and 26.3% were described as skilled workers.

Among the mothers of the former students surveyed, 21.0% had earned master or doctoral degrees. Nearly 50% had earned a bachelor degree or attended 1-3 years of college. Although only 5.3% were employed as scientists, 26.3% were employed as other types of professionals or semi-professionals. Over 30% were employed in skilled and unskilled, sales, or clerical positions, while 26.3% were full-time homemakers. In summary, the parents of the former students appeared to be well-educated and employed in professional/semi-professional occupations. A high percentage of both fathers and mothers were employed outside the home (89.5% and 73.7%, respectively).

When asked whether any science courses had influenced their career decisions, former students indicated that high school biology and college biology courses (average ratings 1.56 and 2.00, respectively) were influential. Students made the following comments about their high school biology course(s).

> My high school biology experiences have benefited my college career by helping me see how interested I really was in biology and, in turn, helping me decide on a major.
>
> The first experience I had with science as an exciting subject came in high school biology. Advanced biology was a difficult course but was good preparation for college level work. It was in high school that genetics was first mentioned. I thought it was a good area for me because I have always done well in math.
>
> My AP biology class changed my mind about my major. I was going to major in applied math but am now in the process of changing my major to microbiology.
>
> I think the high school biology courses and my training in college certainly prepared me for my career in the research area. In my high school biology class I remember going on many field trips. The questioning and searching for information was certainly helpful to what I am doing today.
>
> High school biology has given me a baseline of education in a field I am presently pursuing. Enhancing further knowledge — a challenge to learn more.
>
> High school biology helped me appreciate the richness and diversity of science.
>
> They [high school biology experiences] have taught me what hard work is necessary for obtaining goals.

Overall, the students indicated that they enjoyed their science courses. All respondents (100%) indicated that they had enjoyed their biology courses, 84.2% enjoyed chemistry courses, and 60%-90% liked various mathematics courses. In this sample, then, teachers and courses significantly influenced students' career choices.

As shown in Table 2, students also thought that opportunities for challenge, creativity, independence, and problem-solving activities offered by science careers were important. In fact, when students were asked to indicate the main factors influencing their choice of a science career, they mentioned "challenge" and "being of service to others" more often than any other factors.

Table 2

Student Ratings of the Importance of Career Decision Factors

Activity/Perception	Average Ratings
Challenge	1.42
Independence	1.53
Being curious or creative	1.63
Liking for problem-solving activities	1.68
Being of service to others	1.74
Creativity	1.74
Leadership	1.79
Type of work	1.95
Prestige	2.10
Relevant work experiences	2.16
Security	2.21
Career/occupational information	2.26
Rapid advancement	2.32
Salary	2.32

Note. Scale
1 = Very important   2 = Somewhat important   3 = Of little importance
4 = Not important   5 = Not applicable

Two factors which appear to be of marginal importance in their career choices were high school and college counselors. These categories each received average ratings of 3.58, between "of little importance" and "not important." As shown in Table 3, a large percentage of respondents had never discussed post-graduation education or occupations with a counselor. This lack of contact with counselors was not due to a lack of student interest in career information. Nearly 80% of the students had read career materials in the

Table 3

Percentages of Students Who Have Discussed Future Education and Occupations with Counselors

Discussion of Post-Graduation Training/Education

Number of Times	High School Counselor	College Counselor
Never	15.8%	26.3%
1-2 Times	52.6	26.3
3-4 Times	21.1	21.1
5 or More Times	10.5	26.3
Total	100.0%	100.0%

Discussion of Jobs or Occupations

Number of Times	High School Counselor	College Counselor
Never	26.3%	10.5%
1-2 Times	36.8	36.8
3-4 Times	26.3	21.1
5 or More Times	10.5	31.6
Total	99.9%*	100.0%

*Due to rounding

library, had filled out job applications, and had had a job interview. Over 50% had recently sought career information from school career files or occupational libraries. Perhaps most discouraging were students' written comments about inadequate counseling in high schools and colleges. When asked what they would have changed about their high school preparation, several students mentioned counseling.

> [I would have added]...more counseling, placement in honors, A.P. classes, more college information. More attentions to me and my academic needs!
>
> I would definitely strengthen my math background. I also would switch high school counselors as I was misinformed.
>
> I would have taken 2 years of chemistry and a course in computers. The academic advisors in my high school aren't very good.
>
> I would have taken calculus in high school. More counseling.

> Career information was lacking entirely. We needed to see films, go places and talk to people about their work and see what background they had.
>
> I [a future science teacher] would like to have been offered more advanced placement and honors courses in English, math, and science. In addition, we had little career counseling in high school. I'd like to see more. Also, when I arrived at college, none of my classmates had ever been counseled on the idea of becoming a science teacher. Why not?

In conclusion, although these former students were actively involved in career-related activities, they had little contact with high school or college counselors and, consequently, felt these advisors had little impact on their career decisions.

Students also were questioned about their perceptions of their abilities. As the data in Table 4 indicate, generally students were secure in their academic, scientific, verbal, problem-solving, and social abilities. Students also scored highly in the rating of their "drive to achieve."

Table 4

Self-Ratings of Students by Type of Ability*

% of Students Responding

Ability	Upper 10%	Above Average	Average	Below Average	Lower 10%
Academic	42.1%	52.6%	5.3%	0%	0%
Athletic	15.8	36.8	36.8	10.5	0
Artistic	15.8	31.6	36.8	15.8	0
Mathematical	15.8	47.4	31.6	5.3	0
Mechanical	15.8	26.3	42.1	15.8	0
Speaking	36.8	42.1	21.1	0	0
Scientific	36.8	52.6	10.5	0	0
Problem-solving	36.8	57.9	5.3	0	0
Social Skills	26.3	47.4	26.3	0	0
Drive to Achieve	47.4	52.6	0	0	0

*Ratings were "compared with the average person of your own age."

It has been found that the similarity between a student's self-image and his/her image of a scientist is a good predictor of whether that student chooses to take science classes (Brush, 1979). In order to determine whether this pattern would be found among students who had decided upon careers in science, students were asked to select from a variety of clustered characteristics the groups which best described a "typical scientist" and the groups which best described themselves. The results (Table 5) indicate that a student's self-image is very similar to his/her image of a scientist.

Table 5

Percentages of Students Selecting Groups Which Describe Themselves & Scientists

Characteristics	Groups which best describe...* Yourself	 A Typical Scientist
Realistic, Technical, Mechanical, Outdoor	57.9%	63.2%
Investigative, Scientific, Inquiring, Analytical	78.9%	84.2%
Artistical, Musical, Self-Expressive, Independent	31.6%	5.3%
Social, Helping, Guiding, Group-Oriented	47.4%	26.3%
Enterprising, Profit-Oriented, Persuasive, Political	5.3%	15.8%
Conventional, Methodical, Organized, Detailed	57.9%	68.4%

*Students were asked to choose 3 groups which best described themselves and scientists.

Students felt, however, that they were more socially and artistically-oriented than the typical scientist. This may be due to a lack of personal contact with scientists, since none responded that scientists (except science teachers or parents) had been role models for them and because the sample was predominantly female.

MARRIAGE, FAMILY, AND THE ROLE OF WOMEN IN SCIENCE

When asked what life-role was appropriate for women, the respondents uniformly (94.4%) stated that marriage and/or family combined with a career was optimal. The majority of respondents (78.9%) hoped to marry at 24-28 years of age, and all of the respondents planned to marry. Only 26.3% of the respondents felt they (females) or their wives (males) would work full-time without interruption. The great majority (78.9%) felt that ideally the wife would work full-time before having children and after children were of school age. This may reflect unreal expectations held by college students, since few scientific or medical professions lend themselves to a leave-of-absence of several years. Since part-time employment may hamper career development, the notion that women scientists or physicians can interrupt their careers to raise children without affecting their success is unrealistic. This idea may be due to the lack of scientists as role models with whom these former students have had contact.

When asked whether they agreed or disagreed with a series of statements about women in science careers, these former students responded ambivalently. All of the repondents thought women had as much science ability as men had; 84.2% responded that women as well as men should assume leadership roles in science; and 94.7% disagreed with the statement, "A woman's place is in the home." Nevertheless, over 50% of the respondents felt that it is not more important for a wife to have a career than to help her husband with his career. These former students seem to envision themselves (or their future wives) as "super women" who will carry out all the traditional responsibilities of the wife and mother while pursuing a successful career in science or medicine.

SUMMARY

Nineteen former students of the case study teachers returned completed written surveys, and interviews were conducted with three additional students. The former students consistently indicated that their high school biology teachers had been both inspirations for and enthusiastic supporters of their science career decision. In addition, students cited parents, the challenge of scientific work, the chance to be of service to others, and the opportunity for independence as important factors in their career decisions. Finally, although expressing traditional views concerning the roles of wives and mothers, the female respondents appeared to believe they could successfully combine marriage and family responsibilities with those of a career in science.

References

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Present Students of Case Study Teachers

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INTRODUCTION

Students who were currently enrolled in biology courses taught by the case study teachers were asked to complete several demographic surveys, attitude scales, and cognitive ability tests during the period of observation. Timed instruments were completed in-class, but students finished other surveys and scales at home. Since case study teachers did not score any instruments, students were assured of the confidentiality of their responses. All instruments were coded, according to school, class, and student at Purdue University; and subsequent analyses omitted any reference to student by name.

In addition to questions concerned with demographics (grade, gender, race, etc.), previous academic experiences, and extracurricular activities, students responded to items about their future career plans, including any probability of science careers, as well as their opinions concerning women's roles and scientific abilities. Furthermore, students received a spatial visualization test, a cognitive style test, a locus of control test, a science attribution scale, a science attitudes scale, and a science anxiety scale. These tests were selected and used because scores on each of them have revealed gender differences in previous research. It was hypothesized that there would be no differences between the scores of male and female students for the variables of science attitudes, science anxiety, and participation in extracurricular science activities. In other words, the case study teachers would have had a positive influence on science attitudes, anxieties, and extracurricular activities of girls enrolled in their classes.

STUDENT DESCRIPTION

The sample included 205 female (58.2%) and 147 male (41.8%) students from seven high schools. All teachers and researchers had the option of omitting any or all surveys and instruments; the West Coast school chose to do so. Therefore, students from this high school were not included in the following analyses. As Table 1 shows, the students were primarily 9th and 10th graders. The sample was predominantly white (73.9%) with some black (18.9%), Hispanic (3.7%), and Asian/Pacific Islanders (1.4%) represented. There were no gender differences in racial distribution but, as indicated in Table 2, the schools varied considerably in their racial composition. In general, the majority of students in four schools selected the category, White, not Hispanic; in two schools, they chose the category, Black;

Table 1

Distribution of Students by Grade and Sex

Grade	Male	Female	Total
9	25.3%	22.9%	23.9%
10	63.0	62.9	63.0
11	4.8	10.2	8.0
12	6.8	3.9	5.1
	99.9%*	99.9%*	100.0%

*due to rounding
Note. Sex vs grade: X = 4.83, p = .1850, df = 3

Table 2

Distribution of Students by Race and School

School	American Black	Hispanic	White, Not Hispanic	Asian/ Pacific	Other
Suburban Midwest	1.0%	- %	95.0%	3.0%	1.0%
Rural Midwest	-	1.5	95.5	0	3.0
Urban Rocky Mountain	2.3	2.3	90.9	2.3	2.3
Urban Southwest	13.6	40.9	45.5	-	-
Urban Midwest	87.0	4.3	4.3	-	4.3
Suburban South	95.3	2.3	-	-	2.3
Rural Northeast	-	-	96.1	2.0	2.0

Note. School vs Race: X = 395.55, df = 24, p = .0000 and in one school the majority of students identified themselves as White, not Hispanic and Hispanic.

Students in the sample identified their academic abilities in a fairly typical fashion. For example, when students were asked to estimate their grades, 12.2% said "excellent," 42.0% said "above average," 43.2% said "average," and 2.6% said "below average." Estimates of grades did not differ between the boys and girls in the sample. Students also were asked to estimate their abilities (academic, artistic, social, mechanical, etc.) in relation to those of an average person of their own age. As shown in Table 3, in several categories boys estimated their abilities higher than did girls.

Table 3

Self-Ratings of Abilities by Type of Ability and Sex

	% Responding*					
	Males		Females			
Ability	"Upper 10%"	"Above Ave."	"Upper 10%"	"Above Ave."	X^2 df = 4	Sig Level
Academic	21.8%	41.5%	17.6%	37.7%	7.601	ns
Athletic	20.5	42.5	8.3	30.4	24.873	<.0001
Artistic	7.5	22.4	6.8	22.9	1.213	ns
Math	20.5	27.4	9.3	32.8	10.290	<.05
Mechanical	13.0	32.9	2.0	13.2	48.871	<.0000
Speaking	18.5	41.4	19.1	36.8	1.785	ns
Scientific	17.4	33.3	8.3	24.5	13.538	<.01
Problem-solving	19.2	31.5	7.4	33.0	14.996	<.01
Social	14.3	36.1	12.4	43.1	6.235	ns
Drive to achieve	29.3	40.1	25.9	38.3	1.582	ns

*Responses offered were "Upper 10%," "Above average," "Average," "Below average," and "Lower 10%." Data for only the first two responses are shown. X^2 was performed on all 5 responses.

Although boys and girls gave similar estimates of grades expected (Table 2) and of academic abilities (Table 3), girls rated themselves lower in activities typically stereotyped as masculine. These areas included mathematics, science, mechanics, and problem-solving.

The students reported taking or having taken a wide-variety of honors or advanced placement courses. Over 38% had taken honors/AP math, 40.2% had taken honors/AP English or foreign language, and 27.3% had enrolled in honors/AP social studies. Due to their academic level (9th and 10th grades), few students had had the opportunity to take honors/AP biology, chemistry, or physics (18.4%, 3.8%, and 4.1%, respectively). There were no significant gender differences in enrollment patterns in honors/AP courses at this stage. However, enrollment differences might occur later in the students' high school careers.

Perhaps more important than the lack of gender enrollment differences in honors/AP courses was the lack of differences between boys and girls in the number of courses taken in algebra, plane geometry, trigonometry, college algebra, senior math, calculus, biology, chemistry, and physics.

When surveyed about future educational plans, a large percentage of both boys (85.7%) and girls (76.6%) planned to attend college after high school. Furthermore, as illustrated in Table 4, both boys and girls had high educational aspirations. Over 40% of both planned to earn a master, doctorate, or professional degree. These high educational aspirations might, to a certain extent, reflect the educational levels of the students' parents. For example, 32.2% of their fathers and 35.8% of their mothers had attended 1-3 years of college or had a B.S. or B.A. degree. Over 22% of fathers and 11.6% of mothers held M.S., M.A., Ph.D. or professional degrees. Overall, 74.9% of fathers and 66.4% of mothers had had some kind of post-high school training or education. Parental expectations for these students most likely would include post-high school educational plans.

Table 4

Highest Educational Level Expected in Lifetime By Sex

	% Responding		
Level Expected	Total	Males	Females
Less than high school	1.1%	1.4%	1.0%
High school graduate	2.8	2.7	2.9
Vocational/Military/Business degree	9.7	4.8	13.2
B.S., B.A., or 1-3 yrs. college	43.3	45.9	41.5
M.S., M.A., Ph.D. or professional degree	43.0	45.2	41.5
	100.0%	100.0%	100.1%*

*due to rounding
Note. Sex vs Level: $X^2 = 6.96$, df = 4, p = .1377

CHOOSING A CAREER IN SCIENCE

Students were asked if they had considered science, math, or engineering careers. Significantly more males (79.7%) than females (55.1%) responded positively ($X^2 = 20.561$, df = 1, p = .0000). Likewise, more males (63.1%) than females (47.2%) indicated that they would like to work with scientists to solve problems ($X^2 = 9.02$, df = 3, p = .0291). Finally, a far greater proportion of boys (80.9%) than girls (54.3%) wanted to know more about science or engineering careers ($X^2 = 17.740$, df = 3, p = .0005). When students were asked in what job group they would most prefer to work, their responses were diverse. According to Table 5, in masculine or feminine stereotyped positions both sexes selected jobs which avoided "sex-inappropriate" areas.

Table 5

Percentages of Students Hoping to Work in Various Job Families

	% Responding	
Job Family	Males	Females
General labor, community, and public service	4.6%	6.7%
Secretarial-clerical, office work	7.3	14.9
Construction trades	5.7	2.2
Mechanics, industry trades	6.9	1.1
Proprietors, sales	6.5	4.5
Technical jobs	8.4	3.4
Fine arts, performing arts	6.1	9.3
Humanities, law, social and behavioral sciences	8.8	12.4
General teaching and social service	3.1	6.7
Business administration	0	0
Medical and biological sciences	16.8	19.1
Engineering, physical science, mathematics & architecture	23.0	15.4
Homemaker	2.7	4.2
	99.9%*	99.9%*

*due to rounding

Students also were queried about the importance of the characteristics of a particular job in making a career choice. Males and females selected similar characteristics; that is, high wages, full use of their abilities, opportunities to learn new skills, personal growth, and "important" work were all very important to them. Proportionately more females than males, however, thought that a secure job or future (p = .0114), available job openings (p = .0013), being helpful to others (p = .0069), and the opportunity to work with people (p = .0013) were important.

Finally, students were asked whether they could become scientists. Five percent of females and 12.3% of males indicated that they wanted to become scientists and felt that there were no major obstacles in their paths. Forty percent of males and 48% of females indicated, however, that they did not wish to pursue a scientific career. They felt that there were specific reasons why they could not become scientists. Both boys and girls listed among the important obstacles: indequate grades, excessive educational requirements, and lack of required courses.

In summary, although large percentages of both male and female students in this study (79.7% and 55.1%, respectively) had considered science careers, students - especialy female students - still viewed science and engineering as difficult areas and as predominantly masculine endeavors. Grades, prerequisite courses, and lengthy education were seen as major barriers to becoming a scientist. Most of these students had not taken chemistry, physics, or calculus courses which might be perceived by high school freshmen and sophomores as major academic hurdles to scientific careers.

FACTORS ASSOCIATED WITH SCIENCE CAREER CHOICE

In addition to survey questions directly related to career decisions, students also completed several instruments that assessed factors known to be associated with the choice of a science-related career. Each set of responses was analyzed for gender differences.

Science Attitudes

The "Motz Attitudes Towards Science and Scientists Scale" consists of 21 statements about science and 30 statements about scientists (Motz, 1982). Students selected "agree," "disagree," or "undecided" for each statement. The maximum score for the total scale was 153 points, 63 points for the science items and 90 points for the scientists items. A higher score indicated a positive attitude. Analysis of the data revealed no significant differences between male and female scores for either subtest or for the total scale. Furthermore, student attitudes were very positive with school averages ranging from 127 to 135. The lack of gender differences in science attitudes was surprising since prior research (Kahle & Lakes, 1983; Fennema & Sherman, 1977) had reported that girls, when compared to boys, expressed negative attitudes toward science.

Particularly interesting were the comparisons of responses from the 1976-77 National Assessment of Education Progress' survey of attitudes toward science (Kahle & Lakes, 1983) with the responses of this sample. As indicated in Table 6, proportionately more students in this sample felt "curious," "confident," and "successful" in their science classes than did students in the NAEP sample. According to other responses, the case study students also enjoyed their science classes more than did the NAEP sample, and none of the gender differences in attitudes, typically found in children 13 and older, were found. Girls enrolled in classes taught by the case study teachers held science attitudes equally as positive as those of their male peers.

Table 6

Student Attitudes Concerning Science Classes, by Sex and Sample Population

Question	NAEP Sample % Responding			NABT Sample % Responding		
How often have science classes made you feel:	Total	Male	Female	Total	Male	Female
curious?*	50.7%	53.4%	48.1%	85.3%	84.2%	86.1%
stupid?**	60.8	69.5	52.3	45.8	40.4	49.7
confident?*	21.5	26.8	16.4	59.9	59.6	60.2
successful?*	28.2	32.4	24.1	67.9	73.7	63.5
How often do you like to go to science classes?*	37.3%	42.8%	31.9%	70.2%	74.5%	67.2%

*Response = "Often" or "Sometimes"
**Response = "Seldom" or "Never"

Note. In all cases, a significant sex difference was present in the NAEP sample but was not present in the NABT case study sample.

Extracurricular Activities

Students were asked about their participation in a wide variety of extracurricular activities, both science- and non-science-related. Previous research, using data from the 1976-77 National Assessment of Educational Progress, had indicated that a lack of science activities was related to poor science attitudes and lower science achievement levels among young women (Kahle & Lakes, 1983). According to that study, 9-year-old boys and girls held similar, positive attitudes about science and girls were as eager as boys to participate in science activities. By age 13, however, boys, in comparison to girls, had had many more science activities and held significantly more positive attitudes toward science. Furthermore, by age 13, boys achieved higher scores than girls on science tests. By age 17, the gender gap in attitudes, activities, and achievement levels was even larger (Kahle & Lakes, 1983).

In order to determine whether differences in types of extracurricular activities were as prevalent in our sample as in the NAEP one, similar items were used in our survey. As indicated in Table 7, although the 1976-77 NAEP assessment found that boys at age 17 had more experience with the scientific equipment indicated, there were no sex differences among the students of the case study teachers. However, only a rough comparison may be made between the two samples since different statistical analyses were used for each one.

Gender differences also were found in the NABT sample for those activities which dealt with traditionally masculine areas such as electricity, mechanics, and astronomy. Male students of the case study teachers also had more science hobbies, watched more science TV shows, and read more science books than did their female peers. This finding agrees with those of the 1976-77 NAEP survey. One important gender difference was not found in the current study; that is, girls and boys did not significantly differ in number of science projects completed. However, proportionately more males than females in the NAEP sample had done science projects. Furthermore, there were no differences between boys and girls in the NABT sample on participation in science clubs, science fairs, or math/computer clubs.

Table 7

Percentages of NAEP and NABT Students Responding Positively and Presence of Sex Differences in Extracurricular Science Activities

QUESTION Have you ever...	% Responding Positively NAEP** Sample	 NABT*** Sample	Significant Sex Difference* NAEP** Sample	 NABT*** Sample
experimented with erosion?	42.9%	38.7%	Yes	No
used a meter stick?	78.8	93.8	Yes	No
used a barometer?	48.5	57.1	Yes	No
used a computer?	36.2	83.1	Yes	No
used a graduated cylinder?	63.6	79.4	Yes	No
visited a sewage plant?	25.8	19.8	Yes	No
visited a weather station?	24.3	33.9	Yes	No
visited a research laboratory?	31.9	33.2	Yes	No
made a piece of science equipment?	53.1	51.1	Yes	No
made something from junk?	81.4	70.8	Yes	No
collected leaves/flowers?	83.3	95.1	Yes	No
found a fossil?	60.0	64.0	Yes	No
seen an animal skeleton?	87.7	86.7	Yes	No
seen an eclipse of the moon or sun?	78.7	79.7	Yes	No
seen the moon thru a telescope?	56.8	52.9	Yes	No
seen a solar heat collector?	19.9	43.9	Yes	No

*Significance levels are not included because the data treatment in each case was not identical. The comparisons, therefore, are only estimates. Percentages of males were higher than females in each case where a significant sex difference was found.
**17-year-olds
***Present students of case study teachers, predominantly 10th grade.

Students also were questioned about a variety of other curricular and extracurricular activities. Gender differences were not found for student participation in band, speech/debate, color guard/drill team, Boy/Girl Scouts, 4-H, Junior Achievement, Future Farmers of America, vocational honoraries, or Young Republicans/Democrats. However, proportionately more boys than girls had participated in intramural and varsity sports and in chess clubs. On the other hand, proportionately more girls than boys had participated in chorus/choir, newspaper/yearbook, thespians/drama club, cheerleading and pep club, and language clubs. Most of these activities generally are considered "masculine" or "feminine," and the gender differences in participation reflected those stereotypes. It is, therefore, even more important that differences were not found between percentages of boys and girls participating in science clubs, science fairs, or math/computer clubs.

Locus of Control

Locus of control has been defined as "...an expression of the extent to which individuals believe that they, rather than outside factors, control their own lives" (Carter, 1983, p. 33). Traditionally, women have scored higher (more externally) than men on locus of control measures (Phares, 1976; Kahle, 1982). Furthermore, students with positive science attitudes and with intentions to pursue science careers have generally scored more internally on locus of control measures (Kahle, 1982). With this in mind, case study students were asked to complete the Adult Nowicki-Strickland Scale, a modified version of an earlier instrument developed by Phares (1957). The scale has a maximum score of 40 with lower scores indicating internal orientation. Results from this sample were both surprising and encouraging: There were no gender differences in any of the seven subsamples or in the total sample; and students generally scored at the internal end of the scale. As Table 8 indicates, mean scores for each school ranged from 11.5 to 15. There was only one significant difference found between any of the seven schools; students in the Suburban South school scored significantly more external than those at the Suburban Midwest school ($p<.05$).

Table 8

Mean Scores on Adult Nowicki-Strickland Scale, Hidden Figures Test, and Flags Test by School

School	Hidden Figures Test X	Nowicki-Strickland Scale X	Flags Test X
Suburban Midwest	10.6	11.5	84.4
Rural Midwest	9.2	12.0	74.6
Urban Rocky Mountain	14.5	12.0	73.3
Urban Southwest	4.5	11.8	58.6
Urban Midwest	6.9	12.6	51.9
Suburban South	9.3	15.0	73.0
Rural Northeast	12.6	11.6	70.9
Maximum Possible Score	32	40	126

Cognitive Style

In addition to locus of control orientation, students took the Hidden Figures Test (HFT) (ETS, 1971) to determine their mode of cognitive style. The HFT differentiates between persons with a field-independent and a field-dependent mode. Usually, field-independent persons are better at cognitive restructuring tasks, tend to think analytically, and are more autonomous in personal relations and work behaviors. Field-dependent persons, on the other hand, display social behaviors useful for interpersonal relationships, tend to have extended experience in working with others and gathering information from them, and are less autonomous (Witkin & Goodenough, 1981). Field-independent students tend to choose majors in science, math, art, experimental psychology, engineering, and architecture. Field-dependent students are more likely to choose sociology, humanities, languages, social work, social services (religion), elementary school teaching, education, clinical psychology, writing, and nursing majors (Witkin, et al., 1977a; Witkin, et al., 1977b; DeRussy & Futch, 1971). Finally, there is some evidence that field-independent persons earn higher science achievement scores than do field-dependent persons (Matyas, 1982).

Although gender differences have been reported with more males than females scoring on the field-independent side of the scale (Witkin & Goodenough, 1981), results from the present study do not concur with those findings. In this case, there were no differences related to subject's gender across schools or in any individual school. As Table 8 shows, although mean scores for the student sample in each school were fairly low, they were consistent across school samples. It might be that the Hidden Figures Test either was too difficult for this age group or was inappropriately administered (Table 8). Nevertheless, the absence of differences by gender is surprising and encouraging.

Spatial Ability

Spatial ability may be defined as the ability to visualize objects in three-dimensions in one's mind and to rotate them within their field. Although Maccoby & Jacklin's (1974) review concluded that spatial ability was one of the few attributes for which gender differences were consistently found, Marcia Linn's (1983) recent meta-analysis indicates that research has not shown that males possess superior spatial abilities.

The case study students were asked to complete a modified version of the Flags Test (Thurstone & Jeffrey, 1956) in order to measure spatial ability. Analysis of the results indicated that, for the total sample, a significant sex difference was present with males scoring higher than females ($p = .0013$). Further analysis revealed, as shown in Table 8, that the gender difference was mainly due to a significant difference found in two of the seven samples. Male students in both the suburban Midwest and the urban Midwest schools scored significantly higher than did female students. On this test, students at these two schools composed the opposite ends of the range of the school means. Therefore, they might represent the extreme ends of mostly overlapping distributions. According to these results, boys performed significantly better than girls on a measure of spatial ability in two of the seven high schools surveyed.

Science Anxiety

Science anxiety, like math anxiety, has been defined as a psychological phenomenon, distinct from test anxiety (Alvaro, 1978). The Science Anxiety Questionnaire developed by Alvaro requires students to estimate the degree to which they are frightened by a variety of science and non-science activities. Higher scores indicate lower anxiety levels. Anxiety scores related to science and non-science activities were calculated separately for each student.

Analyses of results indicate that, overall, these students expressed very little science or non-science anxiety. Furthermore, as Table 9 indicates, there were no significant gender differences on either subscale of the questionnaire.

Table 9

Student Scores on Science Anxiety Questionnaire by Subtest and Sex

		Maximum Possible		
Subtest	**Scores**	$\bar{X}$ (Male)*	$\bar{X}$ (Female)*	Sig. Level
Science	29	23.272	23.018	.1746
Non-Science	15	11.218	11.231	.5845

*average number of "not at all" and "a little" responses

Since previous research has indicated that science anxiety may be more prevalent among females than it is among males and that teacher behavior and parental influence may affect science anxiety levels (Alvaro, 1978), the lack of different anxiety levels toward science by boys and girls in this study was important.

Science Attribution

The Science Attribution Scale is a modified version of Fennema, Wolleat, and Pedro's Mathematics Attribution Scale (1979). The scale presents students with nine biology course situations in which the student is told that he/she has succeeded or failed. For example, "You are able to understand a difficult unit of biology" and "You have not been able to keep up with most of the class in biology." After each situation, the student is asked to agree or disagree with four different reasons for his/her success or failure: his/her ability, his/her effort; the difficulty of the task; and other environmental conditions (the teacher, friends, luck, etc.). Students were scored for the number of "agree" and "strongly agree" responses given.

Previous research with non-scientific tasks has found that males attribute success/failure significantly more to ability and effort than do females (Pasquella, Mednick, & Murray, 1981). In the present study, however, no gender differences were found in attributions to ability, effort, or environmental factors. A significant gender difference did occur, however, in attributions to task difficulty; girls attributed success/failure more to task difficulty/

ease than did boys (p = .0227). Finally, in previous work subjects generally gave highest attributions for success/failure to ability and effort. In this study, however, the rank of average attribution scores for both boys and girls was as follows: 1) Effort ($\bar{X} = 6.08$), 2) Task Difficulty ($\bar{X} = 5.27$), 3) Environmental Factors ($\bar{X} = 4.02$), and 4) Ability ($\bar{X} = 3.78$). It appears, then, that these students felt that effort, more than ability, was important in their successes and failures in biology.

Family, Teachers, Counselors, and Peers

"Significant others" is a term used frequently to describe those persons who might influence a student's career choice. The case study students were asked to indicate with whom they had talked about jobs, work, or careers. Proportionately more females than males had talked with family members (97% versus 91%, respectively). Over 90% of both boys and girls had discussed careers with friends and nearly 60% had discussed careers with teachers. Furthermore, students indicated that the case study teacher, in particular, had encouraged students to consider education and/or training beyond high school (76.5% of females, 67.1% of males), had given students advice on what to do after high school (37.9% of females, 38.7% of males), and had encouraged students to explore many choices for post high school plans (42.2% of females, 47.5% of males). There were no gender differences in students' perceptions of career counseling from their case study teacher.

What about the high school counselor? Most students were surveyed during the late spring of the 10th grade; therefore, most would have decided on either an academic, vocational, or general course of study. Probably, most of them were actively involved in choosing courses for the following year. Yet, as Table 10 shows, over 35% of girls and 40% of boys had not discussed post-high school training or education with a counselor within the last year. Furthermore, over 40% of girls and 55% of boys had not discussed jobs or occupations with a counselor within the last year. There was one gender difference; girls had discussed jobs/occupations with counselors somewhat more frequently than had boys. In summary, it appeared that these students found family members, teachers, and friends more important sources of career information and advice than were high school counselors.

Table 10

Percentages of Students Who Have Discussed Future Education and Occupations With High School Counselors

Discussion of Post-High School Training/Education*

Number of Times		Males	Females
Never		44.8%	36.8%
1-2		41.4	41.2
3-4		9.0	15.7
5 or More Times		4.8	6.4
	Total	100.0%	100.1%**

Note. $X^2 = 4.70$, df = 3, p = .1954

Discussion of Jobs or Occupations*

Number of Times		Males	Females
Never		55.9%	40.7%
1-2		32.9	43.6
3-4		6.3	11.3
5 or More Times		4.9	4.4
	Total	100.0%	100.0%

Note. $X^2 = 8.95$, df = 3, p = .0299

*during the past year
**due to rounding

Attitudes Toward Women in Science

Students were asked a series of questions about their perceptions of the role of women in the work force and in the home and, specifically, about the role of women as scientists. Although 25.7% of males and 37.9% of females planned to marry between 18 and 23 years of age, over half (61.8% of males and 51.7% of females) planned to marry at a later age, 24-28 years of age. That choice, perhaps, reflected their educational plans. Few students (less than 6%) expected not to marry.

Students, however, did not feel that marriage might preclude outside employment for women. When asked, "What do you approve of for most women?," 92.1% of girls and 79.7% of boys chose marriage/family combined with a career as the best option. Over 17% of boys, but only 5% of girls, felt that marriage/family alone was best; fewer than 3% of students felt that a career alone was most appropriate for women. In addition, students were asked to express their feelings about the type of employment their wife (males) or themselves (females) would accept. The data in Table 11 shows that the majority of girls and a large percentage of boys felt that the wife in their family would work full-time until she had children. Then, she would leave the labor force and resume work only after the children entered school. A sizeable proportion of boys did not know what their wives' employment was likely to be, and a surprisingly low proportion of boys and girls expected the wife in their family to work full-time without interruption.

Table 11

Student Plans for Future Employment of Wife (Males) or Self (Females)

	% Responding		
Type of Employment	Total	Males	Females
None	2.0%	2.8%	1.5%
Only part-time	12.7	16.6	10.0
Full-time before children and after children enter school	51.7	42.1	58.7
Full-time, no interruption	13.9	11.7	15.4
Don't know/don't plan to marry	19.7	26.9	14.4
Total	100.0%	100.1%*	100.0%

*due to rounding
Note. $X^2 = 15.55$, df = 4, p = .0037

Students were also asked whether they approved of science careers for women. Although proportionately more women than men expressed approval, the percentages of both boys and girls who approve of science careers for women was very large, as shown in Table 12. Despite that encouraging finding, the boys and girls surveyed differed considerably when questioned further on the issue of women in scientific careers. Table 13 presents student responses to a series of statements about women in scientific as well as other types of careers. In all but two cases, girls expressed stronger beliefs in a woman's potential for success in a traditionally masculine career (astronautics, government, science).

Table 12

Student Opinions Concerning Science Careers for Women

Opinion	% Responding Total	 Males	 Females
Approve	77.2%	69.1%	82.9%
Probably Approve	6.5	9.4	4.5
No Opinion	13.9	18.0	11.1
Probably Disapprove	0.9	0	1.5
Disapprove	1.5	3.6	0

Note. $X^2 = 17.05$, df = 4, p = .0019

In summary, it appeared that both the boys and girls surveyed theoretically supported not only women's pursuit of careers in general, but also women's right to pursue science careers in particular. They, unfortunately, held misconceptions about the possibility of interrupting a successful career without damage to it. Finally boys, compared to girls, continued to hold more negative and more stereotypic views about the role of women in science-related careers. Yet, overall, both male and female students of case study teachers held fairly positive views about the potential of women, particularly of women scientists.

Table 13

Student Agreement With Statements Concerning Women in Science

Statement	% Males Responding		% Females Responding		Significance Level*
	Strongly Agree	Agree	Strongly Agree	Agree	
Women are as interested in mathematics as are men.	37.6%	53.2%	48.0%	44.0%	ns
Men don't like to work for women supervisors.	23.6	42.9	21.0	51.5	ns
Women should stick to "women's jobs."	7.4	20.0	3.6	4.1	.0000
Women have as much science ability as men do.	38.8	49.6	63.2	33.3	.0001
Education is wasted on women since they usually get married & raise a family.	5.9	11.0	3.1	2.6	.0000
Women have the ability & endurance to make successful space flights.	19.3	56.4	44.2	49.7	.0000
According to the latest Census data, equal job opportunities have now been achieved.	10.8	46.8	6.5	50.2	.0485
I strongly approve the election of women as governors.	18.8	50.7	56.2	34.8	.0000
I approve of appointing a woman as chairperson of the Atomic Energy Commission.	19.0	51.8	46.5	47.0	.0000
I would choose for myself the best qualified dentist available regardless of sex.	53.2	36.2	71.4	20.6	.0058

*χ^2 test, df = 4

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Descriptions of Success:
The Case Study Teachers

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INTRODUCTION

The teachers selected for observation were chosen on the basis of proven records of success in encouraging girls to continue science. The selection process involved discussions with students, parents, and administrators as well as the identification of biology teachers whose female students subsequently enrolled in physics and chemistry courses. Each teacher selected identified four to six women who have continued in college science majors or entered scientific careers. The teachers also were selected from communities and schools which represented a range of geographic, racial, and socioeconomic conditions.

The teachers were informed that they were selected in order to observe ways of encouraging students to enter science careers. Their success in encouraging girls in science was not mentioned until each study was well underway in order to prevent sensitization of the teacher and introduction of any bias in her/his usual behavior and teaching.

Prior to the observational period, each teacher was asked to complete a personal and educational survey which contained four parts. Parts I, II, and III were a modified version of the survey used by Weiss for the National Science Foundation Survey of Science Education (Weiss, 1978). Teachers were asked to respond to questions concerning their educational background, curricular materials, teaching methods, professional activities, science attitudes, student characteristics, and school facilities. In this chapter, the responses of the case study teachers are compared to those received from the national teacher sample in 1978. Part IV of the survey was developed solely for this project; it contained demographic items as well as items concerning sexism in classrooms (e.g., sexism in texts or in teaching techniques). Although all teachers completed the survey, the responses of the mathematics teacher are not included in this discussion.

CHARACTERISTICS OF CASE STUDY TEACHERS

The case study teachers were all experienced teachers; they had spent an average of 18.4 years in the classroom. All had Master's degrees; and five of the seven teachers held at least one biology degree. These instructors taught between two and six hours of biology classes a day and spent four or more hours a week preparing science lessons. Four of the teachers sponsored a science club at their high school. In general, the teachers thought their science programs were well supported by their school communities. Responses to items quiering sources of support rated parental support the highest. It was followed by support from other teachers, principals, superintendents, and school boards, in that order. Seventy-one percent of the teachers reported that they were more enthusiastic about teaching now than when they began their careers.

Part III of the survey was a science attitude inventory. Teachers were asked whether they strongly agreed, agreed, disagreed, or strongly disagreed with a series of statements about science. Higher scores indicated more positive science attitudes. The maximum score possible was 240. The case study teachers had an average score of 198.57 +/- 14.88, indicating very positive attitudes toward science.

All seven educators provided their students with information about a variety of science careers. In addition, all stated an awareness of sexism in science. For example, 71% of these teachers stated that they included information about the important contributions of women scientists in their class discussions and that they tried to correct the conception that science is an exclusively male domain. Seventy-one percent of them had invited female scientists to their classes to discuss science careers with their students. In addition, 43% used feminine pronouns when describing scientists at work.

The case study teachers are active professionals. All but one have attended at least one science-related professional meeting within the last ten years. Eighty-six percent have made presentations at local science teacher meetings or at inservice teacher education functions. Most of them have been involved in science-related activities outside of their school. For example, several have coordinated science workshops and science fairs, one is on the local park board, and one has been on the staff of a college marine biology institute.

Hobbies of these educators ranged from soapbox racing and hot air ballooning to reading and gardening. Several indicated that they enjoyed photography and had science-related hobbies such as bird-watching and wildlife exploring.

COMPARISON OF CASE STUDY TEACHERS AND NATIONAL SURVEY TEACHERS

The responses from Part I of the case study teacher survey were compared with those reported in the 1977-78 National Science Foundation Survey of Science Education, a national survey of teachers (Weiss, 1978). Although these results are not directly comparable due to the difference in sample size between the national and case study samples (586 teachers vs 7 teachers, respectively), rough comparisons can be drawn. It should be noted, however, that 14.3% of case study teachers represents one teacher; and 28.6% represents two teachers. Tabular data, therefore, should be interpreted with this in mind.

The case study teachers taught an average of 18.4 years and all of them held college degrees beyond the Bachelor level. Science teachers in the national survey, on the other hand, had taught an average of 11.8 years and only 54% held advanced degrees. Eighty-six percent of the case study teachers were women; nationally, women compose 24% of all science teachers.

Both groups of teachers had approximately the same number of students per class; the average was 25.2 students/class for case study teachers and 22.8 for national survey teachers. Table 1 indicates how these teachers rated the ability of students in their classes. While the majority of teachers in both

Table 1
Percentages of Teachers With Classes of Various Academic Abilities

Academic Ability of Classes	NABT* Sample	National** Sample
Primarily high ability students	42.9%	32%
Primarily low ability students	0	14
Primarily average ability students or students of widely differing ability levels	57.1	51

* Refers to case study teachers
** Refers to Weiss sample

groups reported their classes were composed mainly of students with average ability or widely differing ability levels, more case study teachers than national survey teachers taught high ability students. However, none of the case study teachers were teaching classes composed primarily of low abiity students.

Teachers, responding to both surveys, also ranked the usefulness of various sources of information concerning curricular materials and new developments in education. As Table 2 shows, neither case study teachers nor national survey teachers considered principals, state department personnel, or

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Table 2

Teacher Information Sources for Educational Developments and Curriculum Materials

	Concerning New Developments in Education*		Concerning Curriculum Materials**	
Source of Information	NABT Sample	Natl. Sample	NABT Sample	Natl. Sample
Other teachers	42.9%	38%	71.4%	62%
Principals	0	9	0	8
Local subject specialists/ coordinators	0	11	42.9	18
State department personnel	14.3	4	0	3
College courses	71.4	48	71.4	54
Local in-service programs	42.9	21	14.3	19
Federally-sponsored workshops	33.3	29	28.6	19
Teacher union meetings	16.7	6	0	2
Professional organization meetings	42.9	27	57.1	19
Journals/professional publications	71.4	54	57.1	27
Publishers/sales representatives	0	10	71.4	40

* Percent responding "very useful"
** Percent indicating this was a "major" source of information

teacher union meetings good sources of curricular or educational information. In addition, very few teachers in either group indicated that local subject specialists and publishers/sales representatives were useful sources of information concerning new developments in education or that local in-service programs were a major source of information concerning curricular materials. These two groups of educators differ, however, in their assessments of the usefulness of college courses, professional organization meetings, and professional journals. For example, proportionately three times as many case study teachers indicated that meetings of professional organizations were major sources of information concerning curriculum materials. These experienced teachers probably were more active in professional organizations than a non-selective sample would be.

Teachers were asked to identify problems they encountered as science teachers, such as maintaining equipment, inadequate facilities, excessive class size, etc. The data in Table 3 indicate that less than one-third of the case study teachers considered the suggested obstacles as problems.

Table 3

Identified Problems in Science Teaching

	Percentage of Teachers	
Problem*	NABT Sample	Natl. Sample
Belief that science is less important than other subjects	0%	5%
Inadequate facilities	0	20
Insufficient funds for equipment/supplies	14.3	27
Lack of materials for individualizing instruction	14.3	28
Out-of-date teaching materials	14.3	8
Lack of student interest	0	20
Inadequate student reading abilities	14.3	45
Lack of teacher planning time	28.6	14
Not enough time to teach science	0	10
Classes too large	0	22
Problem**		
Establishing instructional objectives	0%	17%
Learning new teaching methods	28.6	43
Obtaining information about instructional materials	28.6	41
Obtaining subject matter information	0	27
Implementing discovery/inquiry approach	28.6	36
Using manipulative/hands-on materials	14.3	34
Maintaining equipment	28.6	36
Working with small groups of students	14.3	31
Articulating instruction across grade levels	14.3	40
Maintaining live animals/plants	0	25

* Response = "Serious Problem"

** Response = "Would Like Assistance [from Science Education Resource Person] But Receive Little or None"

Nationally teachers ranked inadequate facilities, lack of student interest, inadequate student reading abilities, and large class sizes as problems. Although class sizes reported by both groups were approximately the same, only teachers in the national survey indicated that class size was a barrier to effective science teaching. Proportionately more national survey teachers than case study teachers indicated they wanted assistance in obtaining information about new teaching methods and instructional materials. Other responses of the case study teachers indicated that they requested and received such information from college courses, professional organizations, and professional journals.

Teachers in both the case study and the national samples responded that improvement was needed in building/classroom facilties (28.6% and 34%, respectively), space for classroom preparation (28.6% and 28%, respectively), space for small group work (42.9% and 44%, respectively), and availability of laboratory assistants or paraprofessionals (71.4% and 62%, respectively). The case study teachers compared to the national survey teachers did not report a need for more equipment (9% vs 35%, respectively), supplies(0% vs 21%), money for daily supplies (14.3% vs 47%), or storage space (14.3% vs 39%).

The frequency with which science instructors used various teaching techniques are summarized in Table 4. In general, the case study teachers used more varied techniques more often than did the national survey teachers. A majority of the instructors observed in this study used televised instruction and programmed instruction at least once a month, whereas the majority of instructors in the national sample did not use these methods of instruction. Particularly notable differences between the two groups were found in the use of hands-on laboratory materials, tests and quizzes, field trips, and guest speakers. Over 80% of the case study teachers used laboratory materials in their classes at least once a week; less than half of the national survey teachers used hands-on materials that often. All of the case study teachers

Table 4

Use of Various Teaching Techniques by Frequency

	Percentage of Teachers					
	Never		Monthly		Weekly	
Technique/Equipment	NABT Sample	Natl. Sample	NABT Sample	Natl. Sample	NABT Sample	Natl. Sample
Lecture	0%	16%	28.6%	15%	71.4%	63%
Discussion	0	1	0	8	100	85
Library Work	0	29	85.7	55	14.3	11
Hands-on lab materials	0	9	14.3	35	85.7	48
Televised instruction	14.3	69	85.7	18	0	6
Programmed instruction	28.6	71	71.4	16	0	4
Computer-assisted instruction	57.1	90	42.9	2	0	0
Tests/Quizzes	0	18	0	40	100	37
Field Trips	0	31	100	62	0	0
Guest speakers	0	54	100	39	0	1

gave their classes tests or quizzes every week, while slightly over one-third of the national survey teachers tested their classes on a weekly basis. In addition, all of the case study teachers organized field trips and invited guest speakers into their classes. However, almost one-third of the national sample never took field trips, and over one-half never invited guest speakers to their classes.

Table 5 indicates the percentages of instructors who used various audio-visual equipment and science materials in their teaching. Large differences in the frequency with which the two groups used these materials were evident. A majority of the case study teachers used filmstrips, film loops, and slides at least once a month; less than one-half of the national survey teachers used these media that often. Over one-half of the national sample indicated that videotapes were not needed for their teaching; although most case study teachers did not use videotapes often (85.7% responded they used this item "less than once a month"), all of these teachers indicated that videotapes were necessary for their instruction.

Table 5

Use of Audio-Visual Equipment and Science Materials by Frequency and Availability

	Percentage of Teachers					
	Used Once Per Month or More		Needed but Not Available		Not Needed	
Audio-Visual Equipment	NABT Sample	Natl. Sample	NABT Sample	Natl. Sample	NABT Sample	Natl. Sample
Films	71.4%	55%	0%	9%	0%	5%
Filmstrips	100	48	0	8	0	8
Film loops	57.1	8	14.3	22	0	38
Slides	71.4	10	14.3	20	0	32
Overheads	71.4	38	0	4	28.6	19
Videotape	0	10	14.3	16	0	54
Science Materials	Used More Than 10 Days		Needed but Not Available		Not Needed	
Calculators	28.6%	26%	14.3%	14%	14.3%	47%
Microscopes	100	50	0	1	0	33
Models	85.7	44	0	12	0	15
Balance	71.4	57	14.3	1	0	9
Living Plants	71.4	38	0	4	0	39
Living Animals	71.4	28	0	7	0	43

Dramatic differences also were observed in the use of science materials by these two groups of science instructors. All of the case study teachers indicated that microscopes, models, balances, living plants, and living animals were essential for teaching their science classes and a large majority of these teachers used these materials 10 or more days. One-third or more of the national survey teachers responded that microscopes, living plants, and living animals were unnecessary for instructing their classes. Furthermore, all of the case study teachers used microscopes 10 or more days, while only one-half of the national survey teachers used microscopes so often.

SUMMARY

The case study teachers were all experienced teachers and active professionals. Responses to a science education survey taken by teachers were compared with those from the same survey given to a national sample of science teachers in 1978. Proportionately more case study teachers than national survey teachers cited professional organization meetings and professional journals as important sources of information for curriculum materials and new educational developments. The case study teachers were confident in their teaching ability; proportionately fewer of these teachers than national survey teachers indicated that they needed assistance in various aspects of teaching such as obtaining information about instructional materials, using manipulative materials, or maintaining plants and animals. Although these teachers used many kinds of laboratory materials, none of them indicated that inadequate facilities were a serious problem or that improvement was needed in obtaining equipment or supplies. The successful case study teachers showed greater willingness than the national survey teachers to use varied methods of instruction, and they emphasized hands-on science experience for their students in teaching their courses.

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In Summary: Some Commonalities & Themes

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INTRODUCTION

Throughout this study we have asked, individually and collectively, what makes these teachers exceptional? How do they succeed, not only in encouraging girls, but in inspiring both boys and girls in science? What commonalities are found in these classrooms from the East Coast to the West Coast, from center city to rural community, from modern edifice to deteriorating facade? What theme unites their work and our study? The answers have been obtained from hours of transcribed interviews, from dozens of former student notes and messages, from carefully articulated reports of trained observers, from responses to thousands of survey items, and from a critical review of the literature. In summary, this report is both a qualitative and quantitative assessment of teachers who make a difference.

Two types of research, observational and survey, have provided the descriptions and data in this report. Observational studies, commonly called case studies, rely on a knowledgeable observer for their reliability and validity. This mode of research has been accepted in science education since Stake & Easley's (1978) report to the National Science Foundation. Harding & Randall (1983) suggest that the demands made on classroom observational research is that it "be capable of detecting a range of verbal and non-verbal interactions (or absence of these) between pupils themselves and between pupils and teachers" (p. 44). Even a cursory reading of the case studies composing this report provides evidence of such interactions. Other researchers have warned that observational studies, by their nature, must focus on overt behavior. Therefore, underlying, but meaningful, features of behavior may be overlooked (Hamilton & Delamont, 1974). Although the ethnographic researcher acknowledges the uniqueness of each classroom and notes its distinguishing features, no attempt is made to provide control or to eliminate variables (Harding & Randall, 1983). Case studies, therefore, attempt to identify complexities of social interactions and to produce descriptive materials which assist in their interpretation. A case study is limited, however, in the extent to which it may produce generalizations applicable to other situations. Therefore, although the case studies of divergent classrooms in eight different economic and geographical regions form the basis of the total report and the foundation of this summary, they have been supplemented with objective data, describing the abilities, activities, and aspirations of both the involved students and teachers.

COMMONALITIES

Communities & Schools

Although commonalities will be discussed among teachers and across student samples, the purpose of our study was to observe in diverse communities. Therefore, there are few similarities among schools or communities. The hope was that eight diverse situations would provide a composite picture as well as a collective pool of data, in which commonalities could be found and from which generalizations could be made. The basic ethnic/racial composition of each school as well as geographical area and community type are found in the Introduction. Using these three groupings we observed in the following types of schools.

Table 1

Number of Schools in Basic Groups

Geographic Area	Community Type	Racial/Ethnic Group
1 Northeast	3 Urban	4 White, Non-Hispanic
3 Midwest	2 Suburban	2 Black
2 South/Southwest	3 Small town/ rural	2 Hispanic
1 Rocky Mountain		
1 West Coast		

The ambience of each school and each community is described in each case study. In addition, the general socio-economic level of children attending each school is presented. In some cases, the general socio-economic level of students within a school was atypical of the community in general; the central city high school in Colorado, the upper-middle class, laboratory school in Louisiana, and the inner city school in Chicago are examples of this situation. In other instances, the school population reflected the general socio-economic level of the community; for example, in Indiana, Maine, and Missouri, the schools were microcosms of their communities. Although political and religious information was reported sporadically, we have every reason to believe that all views are represented approximately proportionally to their national representation. Together the communities and schools form a composite picture of public high schools in the United States.

Classrooms & Instructional Materials & Techniques

Personally, I have visited three of the eight schools and the physical conditions of the buildings vary greatly. However, the biology rooms observed in all are filled with posters, pictures, models, live specimens, equipment, and projects. They are visually stimulating. Descriptions of the remaining five suggest that one commonality among these eight teachers, who have been successful in encouraging girls in science, is an attractive, well-equipped and maintained classroom. Each case study researcher attributes these pleasant learning places to the energy, creativity, and initiative of the individual teacher.

Many of the observed teachers bemoaned the quality of the curricular materials, particularly the text books, available. One suggested that she had gone along with the other teachers in selecting a traditional text, while another one defended her style of "teaching from the text." All of them responded that they used more than one published text (compared to 52% of Weiss's (1978) national sample who used multiple texts) and six of the seven biology teachers reported that they frequently used text replacements or supplements. The most frequently adopted biology text was Otto, J. H., A. Towle, and M. E. Mednick, Modern Biology, New York: Holt, Rinehart, & Winston, 1977.

All texts in use were analyzed for sexism in language, illustrations, citations, and references. These analyses, found in each case study, suggest that although progress had been made, it was limited. Women, for example, were pictured in non-traditional careers and were represented in approximately 50% of the illustrations. However, their meaningful contributions to science were seldom cited or referenced. In addition, teacher-developed instructional materials were examined for any sexist characteristics. Almost all used both pronouns or the plural pronoun; approximately equal numbers of scientists, researchers, etc. were referred to as men or as women. In one lesson concerning superstitions about reproduction and birth, items showing both male and female bias were included. Generally, one commonality among these teachers was the complete absence of sexist language, materials, or humor in their instructional materials.

As a group, the case study teachers taught in a particular way. When compared with the national sample, described by Weiss (1978), they reported using laboratory and discussion activities much more frequently. In addition, all of them responded that they used weekly quizzes or tests. In comparison, only 37% of the national sample responded that they evaluated students at least once a week. The case study teachers invited in guest speakers and took their students on field trips more often than the national sample. Furthermore, students of the case study teachers were more frequently assigned independent projects, library research, and televised instruction. In contrast to the national sample, these teachers less often lectured or performed teacher demonstrations.

All of these responses suggest good science teaching as another commonality among these teachers. In fact, the researchers began to wonder if there were any unique teaching behaviors contributing to their success with girls. We found unique behaviors as we observed their interactions with students, which will be described later. However, it is important to note that laboratory-based science teaching has been found to be an especially effective strategy for interesting girls in science (Harding, 1983). Over and over, girls responded "The labs," to the question, "What do you like best about your high school biology class?" Perhaps it was expressed best by a 15-year-old, black girl in the deep south, who said,

> I enjoyed working with microscopes. We had a cow heart and we opened it up. [We] looked in the microsocpe at the different parts of the inside of the heart and I enjoyed that.

Instructional techniques that involve students also may encourage and excite young women to study science. As a minority girl on the South Side of Chicago stated,

> [My teacher] always has discussions. We always ask questions, and we learn the most from discussions.

In addition to involving students in a variety of instructional activities and to constantly monitoring their progress, the case study teachers were unique in two other aspects of teaching. They provided career information, and related biology to everyday life. Although all students like these aspects of their biology classes, girls, especially, mentioned them. For example, girls attending a wealthy, suburban school commented,

> She gives us up-to-date information and relates it to how we are living today. She does not give us old stuff from the text book.

> If we want to go into a science career, she tells you what classes you should take for a particular career.

When survey responses were tabulated for all case study students, both boys and girls were positive about the instructional techniques of their teachers. As Table 1 shows, these teachers were uniformly fair in their treatment and expectations of both boys and girls. In fact, this unisex treatment was another commonality found. Unfortunately, most teachers still hold, consciously or unconsciously, sex-stereotypes which affect their classroom behaviors. The importance of teacher behvior and instructional style cannot be underestimated. Jan Harding (1983) suggests that they may be more influential in encouraging girls in science than the presence of a same-sex role model as a science teacher.

Table 1

Male & Female Students' Perceptions of Their Case Study Teacher

	Students Who Agree		df = 1
Does your biology teacher...	% of Males	% of Females	Sig.
encourage you to be creative, original?	58.2%	66.8%	ns
differentiate between jobs for males and for females?	27.0	23.3	ns
frequently talk with you individually?	57.4	54.5	ns
encourage education and/or training beyond high school?	67.1	76.5	.1201
describe science courses work as difficult?	28.9	21.5	ns
give advice on future plans?	38.7	37.9	ns
encourage mathematics courses?	50.3	44.0	ns
encourage optional choices for post-high school?	47.5	42.2	ns
differentiate between courses in which males and females can be successful?	27.1	14.0	.0094
encourage basic skills?	70.5	72.4	ns
treat you childishly?	20.1	12.5	.1008
seldom take your opinions seriously?	18.0	18.5	ns

Student Outcomes

As noted, all students in the observed classes were actively involved in learning. However, each case study teacher practiced what Shirley Malcolm (1983) calls "directed intervention." That is, girls as well as boys could not sit passively in the back of these rooms. Girls were called upon to recite, were requested to assist in demonstrations, were selected to be group leaders, and were expected to perform experiments. They could simply not get by taking notes as boys directed, titrated, measured, etc. The effect of this instructional strategy showed when the responses of these students were compared with those from the 1976-77 National Assessment of Educational Progress' survey of science. Table 2 illustrates percentages responding to items which showed active participation in science classes. Overwhelmingly, young women in the case study classrooms have had more opportunities to use scientific apparatus, to conduct science experiments, and to participate in scientific field trips.

Table 2

Percentage of Females Responding Positively to Selected Items in 1977 NAEP Survey and in 1983 NABT Survey

	% Responding Positively	
	1977	1983
Have you ever worked with...		
electricity	59.4%	69.5%
erosion	38.9	36.9
human-behavior	59.6	67.4
Have you ever used a...		
meterstick	74.2	93.1
barometer	40.8	55.7
computer	32.6	82.2
graduated cylinder	59.2	81.5
Have you ever visited...		
electric plant	34.3	25.4
sewage plant	20.9	16.8
weather station	22.2	32.8
research laboratory	28.2	34.6

As the result of more experiences, more career information, and more encouragement they also demonstrated more positive attitudes toward science classes and science careers, as Table 3 shows.

Table 3

Percentages of Females Responding Positively to Selected Items in 1977 NAEP Survey and 1983 NABT Survey

	% Responding Positively	
	1977	1983
How often have science classes made you feel...		
curious	48.1%	86.1%
stupid	52.3	49.7
confident	16.4	60.2
successful	24.1	63.5
How often do you like to go to science classes?		
often	31.9	67.2
Would you like to work in a science-related job?		
yes	31.7	64.6
Do you want to work with scientists?		
yes	28.6	47.2
Would you like to know more about jobs in a science-engineering field?		
yes	41.5	54.3

Although the percent of girls in case study classes who responded positively was double the national percentage, for each item higher percentages of boys in case study classrooms responded positively.

The effect of these teachers also was noted in the responses of students to instruments assessing science anxiety and attribution, cognitive style, spatial ability, and locus of control. As reported in the Present Student chapter, the good news is that, in most cases, there were no differences between the boys and girls in our sample. Indeed, when differences were found, they were between schools, rather than between sexes in the total sample or within a school. Statistical analyses indicated that geographic and, perhaps, socio-economic factors contributed to the scattered significant differences found.

Responses to the scale concerning science anxiety were particularly interesting. Math anxiety, and to a lesser extent, science anxiety have been suggested as major detriments to girls achieving well in science (Smail, 1983). Others have maintained that experience ameliorates anxiety and that girls particularly must work with scientific materials (Malcolm, 1983; Kahle, 1983). Whether male or female, we found that experience alleviated anxiety. Sample responses in Table 4 show that, in general, girls are more anxious about tests

Table 4

Percentages of Male and Female Students Indicating Anxiety About Science Related and Non-Science Related Activities

	Not At All		A Little		A Fair Amount		Much		Very Much	
How much does it frighten you to:	M	F	M	F	M	F	M	F	M	F
...study for final exam in English or History?*	32.2%	23.8%	28.0%	27.1%	23.7%	16.0%	10.2%	18.2%	5.9%	14.9%
...study for final exam in chemistry or physics?**	31.3	22.7	31.3	23.2	14.8	23.8	13.9	16.0	8.7	14.4
...visit the museum of science and industry?**	40.5	26.0	24.1	32.6	23.3	26.0	8.6	8.3	3.4	7.2
...focus a microscope?*	73.3	85.1	11.2	9.9	7.8	2.2	4.3	2.2	3.4	0.6
...to plan an electrical circuit?**	55.9	30.8	26.3	33.5	15.3	19.8	1.7	11.0	0.8	4.9

Key: Significant differences between male and female responses
* X^2 test, df = 4, p < .05
** X^2 test, df = 4, p < .10

and new experiences such as visiting a museum. However, both sexes demonstrated less anxiety if they were familiar with the task such as focusing a microscope (girls) or planning an electrical circuit (boys).

In spite of positive attitudes toward science, low anxiety levels about science, and increased experiences in science, some girls in the case study classes expressed stereotypic views of science and of scientists. A privileged girl in a suburban high school said,

> Men are scientists. It is a masculine job career. Women don't go into it because being a scientist will make them look bad.

Her opinion was reiterated by a black girl in an inner-city school, who stated,

> If I married a scientist he'd never have time to be home with his family. I think men scientists would have more time than women scientists. It depends on the woman. If she can do it, fine; but most women can't.

But, across the country, girls, at least those in these non-sexist classrooms, were beginning to question the old, masculine views of science and scientists. Two interesting and revealing comments were:

> I don't know if it is women thinking scientists should be men, or men thinking scientists should be men.

> There are some women scientists; but men have been in it longer. Women can do the same job as men. They may have a different way of thinking and might improve science.

Themes

The common theme throughout the classroom observations, the past and present student surveys, the teacher reports, and all the analyses is that good teachers make a difference. Each teacher successful in encouraging girls as well as boys to continue in science courses and careers was also a successful teacher. For example, they were active professionally, were involved in science activities in their communities, were skilled in a variety of instructional techniques, and were informed about scientific careers and their educational requirements. In their own words, they were proud professionals. From the rural Midwest to cities in the deep South they stated,

> Teaching is a profession. I can walk down the street and feel proud that I am a teacher. I think anything we can do as educators to put a feather in our cap; to say, 'hey, this is a proud profession,' is important. Let's build it up and speak positively about it.
>
> In the years I have been teaching, I have become, what I call, dedicated. I try to be professional, and I have influenced the lives of many young people. I have taught required courses and had the opportunity to touch every student who has been through the laboratory school for the last 24 years. I enjoy teaching.

However, unique attributes were identified. These special behaviors and beliefs resulted in proportionately more girls in their classes continuing in math and science courses in both high school and college. In conclusion, the following behaviors characterize teachers who are successful in encouraging girls to pursue science.

Do

- use laboratory & discussion activities
- provide career information
- directly involve girls in science activities
- provide informal academic counseling
- demonstrate unisex treatment in science classrooms

Don't

- use sexist humor
- use sex-stereotyped examples
- distribute sexist classroom materials
- allow boys to dominate discussions or activities
- allow girls to passively resist

Cecily Cannan Selby, who encouraged this project and who was instrumental in funding it, has suggested that excellent science teaching must be innovative and exciting. She says,

> Science must be presented as not only basic but beautiful, as those of us whose lives and professions have been touched by this beauty are so proud and privileged to know (Selby, 1982).

The case study teachers demonstrate those feelings about science. Perhaps, because science is presented as beautiful, they are able to capture and intrigue the girls in their classrooms.

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APPENDIX A

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